THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XX.—NO. 492.

ELECTRIC LOCOMOTION.

ONE of the most remarkable characteristics of the admirably practical paper read by Mr. Reckenzaun last week before the Society of Arts, and one which must have made itself apparent to all his hearers, was the total absence of that egotism which so often detracts from the value of papers read before scientific societies. Such self-sacrifice from the man who has taught his imitators the greater part of the knowledge they possess of the subject under discussion, and whose failures have led to the successes of others, cannot be allowed to pass unnoticed, and we trust that ere long Mr. Reckenzaun's disinterestedness will reap the reward which such a virtue deserves.

One would scarcely credit that so many lectures had been delivered in the hall of the Society of Arts within the last six years, and that so little had been the result of the efforts made to impress upon commercial men the fact that electricity is a cheap and convenient means of locomotion, but we are fain to believe that the Rubicon has now been passed, and that in a short time considerable activity will be manifest in this, the most suitable method of tramcar propulsion in large cities. The facts which the lecturer submitted to his audience respecting the electric tramways on the Continent are full of interest, and if statistics had been forthcoming from American sources also, we fancy that even the tramway director, who thinks of nothing but pounds, shillings and pence, must have been inclined, perhaps against his will, to give serious consideration to the idea of utilising electricity in preference to horses or steam power, so apparent did Mr. Reckenzaun make the economy of the electrical systems passed in review.

We need not here discuss the method of gearing employed by different inventors, nor the systems of conductors, whether underground or overhead; these were ably dealt with in the paper, and one and all appear to have special functions under certain conditions. Suffice it to say that Mr. Reckenzaun made it clear to the most casual observer that electrical propulsion is reliable, and that even now the inclusive cost can be brought down to 3½d. per car mile, and in some cases still lower.

One would naturally have thought that the discussion on a paper of such a practical nature would have brought out much useful information, but, unfortunately, several of the gentlemen who rose to give vent to their feelings did not, like the lecturer, ignore the personal equation, but on the contrary, entered into matters quite beside the questions under consideration, much to the annoyance of those who expected to derive a little intellectual enjoyment from the arguments. Still, amongst the chaff some grain can be found, and it is to these siftings that we mainly desire to draw attention. Perhaps of all the remarks which were passed during the evening those of Sir John Jenkins and Mr. Capper are, to a technical journal, the most important. These gentlemen are connected with a tramway or short railway, from Swansea to the Mumbles, one of the oldest in the kingdom, the Bill for which was originally for a canal. This Bill passed as for the canal on the second reading, but it came out of the House of Commons as a railway in 1804. Sir John Jenkins stated that the cost of running on the railway was less than on ordinary tramways, and the question in all these cases was really which was the cheapest motor. As Mr. Holroyd Smith had said, there was a great objection to electricity on account of the third rail, but independently of that, Sir John did not think the time had yet arrived when electricity could compete with steam power, where it was practicable to use it. The cost of Mr. Reckenzaun's mode of working would be about 3½d. per train mile, but the cost of the small line he referred to was not more than half that. Almost every possible motive power had been tried, including sails, but nothing was so economical as the steam engine.

Mr. R. Capper went further than did his colleague, and said that naturally, having to carry three-quarters of a million of people a year, they looked at all these things very closely, but he had never yet come across any instance of an electric motor, as applied to tramways, which it would answer their purpose to adopt. There was still a field open to anyone who could show them how to make that six miles of line pay better by electricity than it did at present with locomotives.

Now, if we are not mistaken, the locomotives which are employed between Swansea and the Mumbles are built specially for the purpose, and are therefore wasteful in fuel. They draw, we believe, three cars each, and run once an hour, and, in winter, with occasionally not more than half a dozen passengers. Coal, of course, is cheap in Swansea, but then that is also in favour of electricity, although the price of fuel does not amount to a large percentage of the total cost per car mile. What we would like to know is how Sir John Jenkins arrived at his estimate of 1¾d. per train mile. Perhaps he takes into consideration only the cost of fuel; but this is not enough, and until he shows us how his calculations are made we must decline to accept his figures as being anywhere near the truth. We do not make this remark as a mere surmise, but base our belief upon an actual inspection of the line and plant, and upon conversations with Mr. Capper himself, who, unless our memory is a treacherous one, had, even two years ago, a well founded idea that electricity, if absolute dependence could be placed upon its reliability as a motive power, might be made to carry the traffic between the two termini at a cheaper rate than do steam locomotives.

Mr. Capper, we feel sure, has not taken an antipathy to electric locomotion, and therefore we can only think that his very emphatic opinion is the result of a misconception of the actual cost entailed in the work-

ing of the line he represents. The field, as he puts it, is open to any one who can show the managers how to apply electricity economically, and we hope that some one will be found bold enough to enter the lists. There is neither gradient nor curve on the whole line worth taking into consideration, and we believe that at the Mumbles there is water-power in abundance running to waste, which would amply suffice to drive turbines producing more than the necessary motive power.

We do not wish it to be thought that we advocate the employment of electricity on ordinary railways: steam is the right thing in the right place there. But we cannot help thinking that the Swansea-Mumbles line was, unwittingly it is true, constructed to be worked electrically, and we cannot imagine a more suitable locality in which to make the attempt to show what a great field of enterprise is open to the supporters of electrical traction.

Perhaps the Electric Locomotive and Power Company may think it worth while to turn its attention to the little Welsh line, and such a proceeding does not seem very improbable, seeing that the company has a much more ambitious scheme under consideration; but naturally the first question to be decided is that upon the solution of which the early adoption of electric locomotion upon anything like an extensive scale will very greatly depend, viz., the experiments on the North Metropolitan Tramways at Stratford, concerning which the company's chairman, Mr. Richardson, spoke very hopefully last week.

Should electrical traction ultimately triumph—and who can doubt its success who carefully follows the energetic work of our American cousins?—Mr. Reckenzaun will be able justly to claim the distinction of being the first man who made it the subject of earnest labour and scientific reasoning; and we can cordially endorse the remark of Mr. W. H. Preece that never in any paper on this subject were facts more clearly enunciated than in that read before the Society of Arts on Wednesday, April 20th.

THE PRACTICE OF DYNAMO DESIGN.

OUR estimable contemporary the *Electrician*, in an article entitled "Technical Criticism," made last week the following remarks concerning our former reference to Mr. Fricker's formula:—"To those who are at all familiar with Mr. Fricker's previous work in this direction it will necessarily appear in the highest degree probable that such criticism as this in question must be based either upon fallacy or misapprehension. It is, or should be, unnecessary for us to inform our contemporary that Mr. Fricker is as conversant with the practical as with the theoretical side of the question upon which he treats, and it is therefore somewhat surprising that his critic should consider it either safe or becoming to flourish the tomahawk and execute a war dance in such triumphant style without exercising the utmost precaution to ensure that neither fallacy nor misapprehension on his own part shall operate to mar the success of the onslaught.

"We deem it superfluous to add any words of our own in defence of our contributor, who, in a matter of this simple kind, is perfectly well able to take care of himself; but on behalf of the scientific method in dynamo design, as opposed to the foot-rule process advocated by our contemporary, it may be as well to recapitulate briefly, in this place, the exact purpose for which the formula in question is intended to be applied. It will then rest with the critic, laying aside sarcasm, to show how the same thing is to be done with equal exactitude by the process which he recommends. We shall, however, confine ourselves for the present to the briefest statement of facts. A knowledge of the formula in question—which, by the way, is now published for the first time—is the necessary and sufficient condition for obtaining a solution *as exact as the present state of our knowledge admits* of the following problem:—To construct a dynamo of a given configuration, which at a given number of revolutions per minute shall have a given output; or, in other words, to determine the actual linear dimensions of the required machine from a knowledge of certain ratio values of its component parts. The complete solution is readily obtained when once the proper radius of the armature core has been found, and the formula which has excited the derision of our contemporary supplies this value in terms which are implicitly known from the conditions in which the problem is stated. Our readers will probably think that we have given an unnecessary amount of attention to this matter; but we have felt that so long as it is possible for a technical journal to contain a criticism of this order, it is our duty to protest against the idea that problems of this nature, involving as they must, in any case, the expenditure of much time, and thought, and money, should at any time be treated in the crude and unscientific style advocated by our contemporary, apparently for the sole reason that the scientific treatment involves the numerical solution of an admittedly somewhat lengthy formula."

We deny that we have at any time advocated in the designing of dynamos a crude and unscientific method. What we have endeavoured to show from time to time, however, is that a mere display of algebraical legerdemain is not science, nor does ringing the changes on a number of symbols constitute theory. As hinted in our note of last week, we shall, when the series is complete, review both the matter and the method of these papers.

INDUCTION COILS GRAPHICALLY TREATED.

By GISBERT KAPP, in *Industries*.

(*Concluded from page* 369.)

IN the previous article, the question of a single coil having self-induction was treated, and it was shown how, by a simple graphic construction, the resultant current and the lag can be found, if the impressed E.M.F. at the terminals, and the constructive data of the coil, are given. We must now extend the method to the case of

2. *Two Coils.*—Let the symbols previously used stand for the primary coil, and let e^1 i^1 denote induced E.M.F. and current in the secondary, their maxima being E^1 and I^1. The resistance of the secondary circuit we denote by r^1; and if this circuit contain, besides the secondary coil, no other portion having self induction, the three quantities are simply related according to Ohm's law: $E^1 = I^1 r^1$.

(A) *Disregarding the Saturation Term.*—The current in the secondary coil exerts a magnetising force upon the core, which, on the whole, is in opposition to that of the primary coil, although it need not, and, in fact, can never, be diametrically opposed. Let τ^1 represent the number of turns in the secondary coil, then the magnetising force or exciting power in current turns which produces induction, is at any moment $(\tau i - \tau^1 i^1)$; and the total induction is

$$z = \frac{K}{R} (\tau i - \tau^1 i^1).$$

Since we suppose all quantities to vary according to a

sine function, we have also $z = Z \sin a$, where Z is, as before, the maximum total induction. The following equations are self evident :—

$$e^1 = \frac{\tau^1 d z}{d t}$$

$$e^1 = \frac{2 \pi \tau^1}{T} Z \cos a$$

$$i^1 = \frac{2 \pi \tau^1}{T \rho^1} Z \cos a.$$

Since the primary current must also be a sine function, we have $i = I \sin (a + \phi)$, where ϕ is the angle denoting the lead of the primary current over magnetisation. The lead of magnetisation over the secondary current is $\frac{\pi}{2}$, as appears by comparing the equations for z and i^1. The secondary current reaches its maximum value I^1 for $a = 0$, $a = \pi$, &c.

$$i^1 = I^1 \cos a.$$

From the above equation, for z we obtain also—

$$z \frac{R}{K} = \tau I \sin (a + \phi) - \tau^1 I^1 \cos a.$$

Since for $a = 0$, $z = 0$; we have $\tau I \sin \phi = \tau^1 I^1$, and since for $a = \frac{\pi}{2}$, $z = Z$; we have $\tau I \cos \phi = Z \frac{R}{K}$.

From these two equations we obtain the angle of lead ϕ of the primary current over the magnetisation—

$$tg \phi = \frac{\tau^1 I^1}{Z \frac{R}{K}}$$

$Z \frac{R}{K}$ is the exciting power which produces Z lines. If the magnetisation remains within certain limits, this ratio is constant. It will be seen that the lead of the primary current over the magnetisation is independent of the primary current, and of the number of turns in the primary coil ; but depends upon current and turns in the secondary coil. It also increases if the magnetic resistance of the core is decreased, say by employing more iron. The E.M.F. which must be impressed on the terminals of the primary is $e = e_i + e_\rho$

$$e = \frac{2 \pi \tau}{T} Z \cos a + I r \sin (a + \phi)$$

$$e = E_i \cos a + E_\rho \sin (a + \phi).$$

This can be represented as a simple sine function

$$e = E \sin (a + \phi + \psi)$$

where ψ is an angle representing the lead of the impressed E.M.F. at the terminals of the primary coil over the primary current ; and by reasoning analogous to that employed above, we find

$$tg (\phi + \psi) = \frac{E_i + E_\rho \sin \phi}{E_\rho \cos \phi}.$$

In well designed apparatus the resistance of the primary circuit is very small, and the E.M.F. required to overcome it is very small as compared with the induced E.M.F. Hence the ratio $\frac{E_i + E_\rho \sin \phi}{E_\rho \cos \phi}$ has a very large value, and would be infinitely great if the resistance of the primary were zero. It follows that, in such apparatus, the lead of the impressed E.M.F. over magnetisation approaches $\frac{\pi}{2}$ as the resistance of the primary coil and the magnetic resistance of the core are diminished. It further follows that, if these resistances are very low, the impressed E.M.F. at the terminals of the primary and the resultant current in the secondary coil, are almost diametrically opposed in phase. The graphic representation of the above formulæ is very easy. Let, in fig. 3, the radius $\overline{O A}$ of the inner circle represent the effective exciting power $Z \frac{R}{K}$; and that of the second circle the exciting power $\tau^1 I^1$ of the secondary coil alone, then the hypotenuse of the triangle constructed with these two quantities as catheti gives at once the exciting power, $\overline{O I}$, of the primary ; and since the numbers of turns, τ^1 and τ, are supposed to be known, the currents in the secondary and primary for a given total induction are

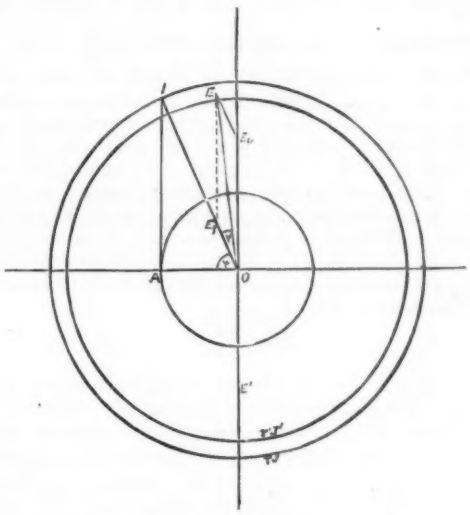


FIG. 3.

easily found. The E.M.F. in the secondary is proportional to the induction, Z. Its maximum value can be calculated by using the formula

$$E^1 = \frac{2 \pi \tau^1}{T} Z ;$$

and this can be graphically represented to a certain scale by the length of the line $\overline{O E^1}$. Imagine, now, the three lines : $\overline{O I}$ representing the maximum current in the primary, $\overline{O A}$ representing maximum exciting power, and, therefore, implicitly also magnetic induction in the core ; and $\overline{O E^1}$ representing maximum induced E.M.F. in the secondary, revolving at uniform speed round the centre O, and let them always keep their angular distances ; then the simultaneous projections of these lines give at any moment the intermediate values for primary current, induction, and secondary E.M.F. By suitably altering the scale, the projection of $\overline{O E^1}$ can also be made to represent the current in the secondary coil. Let—to the scale chosen for representing E.M.F's.—the line $\overline{O E\rho}$ represent the E.M.F. required to overcome the resistance of the primary, and $\overline{O E_i}$ the induced E.M.F. in the primary, both referring to the maximum current, I, then by drawing $\overline{E_i E}$ paralled and equal to $\overline{O E\rho}$, we find the impressed E.M.F. on the terminals of the primary $\overline{O E}$, and the lead ψ of it over the current.

So far, then, we are able, from a knowledge of the configuration of the core (giving R), the quality of its iron (giving K), and the electrical data of the coils (giving number of turns and resistances), to determine the currents and E.M.F's. corresponding to any assumed magnetic induction in the core. But this is not the way the problem is generally met with in practice. We do not find that the induction is given, and impressed E.M.F. or primary current is required to be found, but the opposite. As a general rule, the primary current (series transformer), or the impressed E.M.F. (parallel transformer), is given ; and the only question of practical importance is, what E.M.F. and current can be obtained from the secondary coil. The diagram fig. 3 gives a complete solution to this question, if we enlarge or reduce it, so that the line $\overline{O I}$, or the line $\overline{O E}$ will, to the scales chosen, represent respectively the given primary current or impressed E.M.F.

It is evident that an alteration of current or impressed E.M.F. in the primary will produce proportional alterations in the other qualities (the angles ϕ and ψ, however, remaining unaltered), and we can, therefore, re-draw the diagram so as to suit the given primary current or impressed E.M.F.

The diagram gives implicitly, also, the resistance in the secondary. This is easily seen from the following consideration:—The diagram was constructed on the assumption that the induction, Z, has a certain value corresponding to the exciting power $Z \frac{R}{K}$, which is graphically represented by the length of the radius, O A, of the inner circle. Then we assumed a certain exciting power of the secondary, and represented it by the middle circle, marked τ^1 I^1. Now the assumption of Z carries with it implicitly the assumption of a certain E.M.F., E^1, in the secondary, whilst in fixing the circle representing τ^1 I^1, we have, at the same time, implicitly assumed a certain current, I^1, in the secondary; and since these quantities must be related by Ohm's law, we have in reality also fixed the resistance in the secondary circuit.

$$r^1 = \frac{E^1}{I^1}.$$

Now assume the resistance of the secondary to be varied. To fix ideas, let it be increased. This can be represented in the diagram by either an increase of the radius, O A, or by a decrease of the exciting power of the secondary, A I, or by both alterations simultaneously. Which of these representations we select, depends on the conditions under which the apparatus is supplied with electric energy. If, for instance, it is supplied with a constant current, we must vary both the effective exciting power (and implicitly the E.M.F. and resistance in the secondary) and the secondary current, so that the point, I, should remain on the outer circle. This will give us a series of triangles, O I A, all having an equal length of hypothenuse, but differing catheti, A I and O A, which respectively represent the current and E.M.F. in the secondary. Corresponding values of these two quantities can now be plotted in a curve (fig. 4), which is the characteristic of a series transformer, and which can be used in the same way

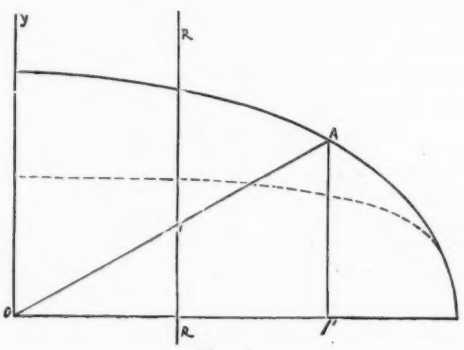


FIG. 4.

as the characteristic of a dynamo. It is evident that this curve must be an ellipse, and might, by a suitable selection of scale, be a circle. By adding a scale of resistances, R R, the current, O I^1, and E.M.F., I^1 A, corresponding to any resistance, r^1, can be read off the diagram, for which purpose it is only necessary to prolong O r^1 to its point of intersection, A, with the characteristic.

The characteristic of a series transformer thus obtained is very instructive. It shows at a glance what alterations take place in the E.M.F. and the current (this refers, of course, to their maxima, but their mean values are in a definite proportion thereto) in the secondary circuit if its resistance be varied, say, for instance, by switching lamps in or out. For very large values of resistance, the alteration of current is proportionately much greater than that of E.M.F., whilst for very low resistances the alterations of current is small compared with that of E.M.F. Thus, if only a few glow lamps are being fed in parallel from the secondary circuit, the switching out of these lamps will not materially increase the pressure in the circuit; but if a sufficient number of lamps be switched on, so as to fully utilise the energy of the transformer, making the product I^1 E^1 a maximum, then the pressure will fall considerably, and the lamps will become dim. On the other hand, we might burn a limited number of low resistance glow lamps in series, and by short circuiting one after another, the current would not be materially increased; but also in this case the energy converted would be much less than could be obtained with the given transformer if worked in a condition represented by the middle portion of the characteristic. It is interesting to note that, even if the secondary coil be completely short circuited, the current in it does not become very great. Roughly speaking, it is twice the current at which the transformer develops the maximum energy. For commercial reasons, it is evidently necessary to work transformers at or near the point of maximum output, and a glance at the curve will show that this class of apparatus (series transformer, with a core sufficiently large to avoid approach to saturation) can never be self-regulating if so used. It can only be made approximately self-regulating if used under conditions represented by either extremity of the characteristic; but as, under these conditions, the output is very small, this is not practicable from a commercial point of view. It will be shown presently that transformers with small cores in which saturation is reached, are in this respect slightly better, although not nearly so perfect, as parallel transformers.

If the condition of supply is constant impressed E.M.F., the point E in fig. 3 must always remain on a circle described with O E as radius. In this case, the process of finding the characteristic is slightly more elaborate, but presents no special difficulty. We assume different values for the current in the secondary, and keep the effective exciting power for the present constant. Thus the point I in fig. 3 assumes different positions on the line A I and its prolongation. To each position corresponds a certain value of O $E\rho$, all the points $E\rho$ lying on a vertical line, whilst O E_i remains, by reason of constant total exciting power, evidently constant. The corresponding points E lie, therefore, on the lines E_i E, each of these lines being drawn parallel to the corresponding line O I, and equal to the corresponding values of O $E\rho$. Since this alters the distance of E to O, it is necessary to make a correction in every case, by increasing or diminishing all the quantities proportionately, so as to bring back the point E to the circle representing the constant impressed E.M.F. The effect of the correction will be to diminish the E.M.F. in the secondary for increasing currents; but if the resistance of the primary be very small, the quantity O $E\rho$ in the diagram must in each case also be very small, and the correction and consequent alteration of E.M.F. becomes trifling. Practically, the characteristic of a parallel transformer is, therefore, a straight and horizontal line, and such a transformer will be almost perfectly self-regulating for constant pressure.

(B) *Taking the saturation term into account.*—The effect of saturation is to make the induced E.M.F's. E^1 and E_i not strictly proportional to the effective exciting power, but rather smaller. The only alteration in diagram fig. 3 will, therefore, be that the point, E^1, will lie inside its former position, and the point, E_i, will also be shifted nearer to the centre. Let O C, in fig. 5, represent the characteristic of magnetisation, drawn to such a scale that the ordinates represent the induced E.M.F. in the secondary (which is evidently proportional to Z), then, by altering them in the ratio of τ to τ', these ordinates can also be made to represent the induced E.M.F. in the primary. If the increase of magnetic resistance did make itself felt equally throughout the whole period, the induced E.M.F. in the secondary corresponding to the exciting power, O A,

would be represented by the line $\overline{O E''} = \overline{A B}$, instead of the line $\overline{O E'} = \overline{A D}$, as before; and the induced E.M.F. in the primary would be represented by the line $\overline{O E_1''}$, instead of $\overline{O E_1}$, the ratio $O E_1'' / O E_1$ being equal to $O E'' / O E'$. The lead of impressed E.M.F. over the current in the primary (ψ in fig. 3) has, in consequence of these alterations, been somewhat decreased, and the impressed E.M.F., $\overline{O E_0}$, in the primary is also smaller than it would be, if it were permissible to

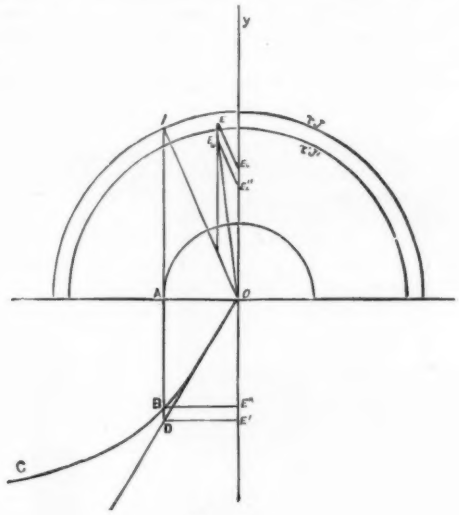


FIG. 5.

neglect the saturation term. Since, however, the effect of saturation is not felt at and near the point where the magnetisation of the core passes through zero, the true value of the E.M.F. in the secondary lies between the points E′ and E″, and that of the impressed E.M.F. in the primary between the points E and E_0. Owing to hysteresis, the true values will be rather nearer E″ and E_0 respectively, and might, for practical purposes, be considered to coincide with these points.

It is interesting to investigate the influence of saturation on the characteristic of a transformer. If the supply be at constant E.M.F., we assume, as before, different positions of the point, I, on the line A I, and its prolongation; ascertain the corresponding positions of E_0, and correct for constant impressed E.M.F. Owing to the relatively greater value of $E\rho$, the corrections will be rather larger than before; but, on the other hand, the influence of these corrections upon $\overline{O E''}$ will be relatively less, since the intersection of the line, $\overline{A D}$, takes place with the curve at B at a more obtuse angle than with the straight line at D. On the whole, therefore, the introduction of the saturation term, whilst lowering the characteristic of a parallel transformer throughout, need not necessarily cause it to depart more from a straight and horizontal line. To work with a high degree of magnetic induction is, therefore, compatible with the attainment of a nearly constant E.M.F. in the secondary circuit. If the supply is on the series system, with a constant current, a construction analogous to that described above gives a characteristic considerably below that found previously near the origin, and coinciding with the previous curve at the more distant points. This curve is indicated by a dotted line in fig. 4.

It will be seen that it contains a somewhat longer portion where the slope is only slight, and this indicates that the variation of E.M.F. in the secondary has been somewhat reduced by reason of saturation. A series transformer, with a small and over saturated core, might, therefore, be made to regulate within somewhat wider limits than one where the core is large; but the regulation can never be perfect, and the output obtainable with a given weight of copper must be less than in a transformer which has a core large enough not to become over saturated.

POLLAK AND BINSWANGER'S PROPOSED ELECTRIC TRAMWAY.

BEFORE describing the Pollak and Binswanger system let us, says M. Reckniewski in *La Lumière Electrique*, rapidly survey the advantages and defects of the different arrangements hitherto proposed.

Broadly speaking there are two systems; in the one the cars convey with them generators of electricity, batteries or accumulators, just as a locomotive carries its boiler; in the other the cars receive, by means of conductors, the electric current produced at a central station.

The Reckenzaun, Julien, &c., systems belong to the first class, and have been brought to a high degree of perfection.

The advantages of this system are that there is no necessity for a special road, the cars may travel upon any line so long as they return at the proper time to the station to take up a fresh charge of accumulators.

The electric energy of the accumulators is expended on the spot without any loss in transmission.

The defects, unfortunately, are rather great; the accumulators make up a considerable dead weight, their carriage requires much care, their duration is limited, after which it is necessary to replace the plates; lastly, the intervention of the accumulators produces a loss of work in the double transformation of which they are the seat. This loss may reach 25 per cent.

Such as it is, however, the system has worked well and seems to give results which are satisfactory from an economical point of view.

In the systems of the second class which seem to have the best future prospect, the electric current generated in a central station is conveyed by two insulated conductors placed along the road upon which rub two brushes fixed to the car. To this class belong most of the American systems.

The advantages, as compared with the foregoing class, consist in the lightening of the car, since its organs of propulsion are reduced to a motor and two brushes or rubbers; and in the suppression of accumulators which involve a great expense and require very nice management.

Finally, in this latter system we have one transformation of energy less; in fact, the electric current from the central station arrives directly at the motor placed upon the car without the intervention of accumulators, which, as we have seen absorb about one-fourth of the energy.

The only and the great difficulty of the systems consists in the arrangement of the insulated conductors conveying the current, and in its continuous introduction into the moving car.

To this point, therefore, the attention of inventors has been directed. It is necessary in the first place to avoid the loss springing from a defective insulation of the conductors placed very near to each other all along the line; it is needful to prevent the accidents and the shocks which might be felt by men and animals who, in crossing the road, happen to touch both conductors at once; it is necessary as far as possible to employ high potentials to reduce the loss from the heating of the conductors. These are conditions partly antagonistic and difficult to reconcile.

All sorts of means have been employed; one rail has been used to bring the current and the other to carry it back, and wheels for introducing it into the car (Volk system, &c.), but the losses from faulty insulation are considerable, especially in wet weather; the rails may be short-circuited if a wire or a bar of metal falls across the road, and men and animals may receive shocks. Hence this system cannot be employed in towns.

Aerial conductors have been used upon which there are two small travellers drawn by the car, and which must make contact (Siemens system); this scheme also is inapplicable in towns where aerial conductors are prohibited.

A method more practical, but very costly, has been to make use of the rails to form one of the conductors

and to place the other in a casing arranged under the road and communicating with the exterior by a narrow slit. A rubber attached to the car penetrates into the casing by the slit and plays against the conductor; from this rubber the current enters the motor and returns by the wheels to the rails.

Fitting up the underground casing involves much expense; besides it is liable to be clogged with sand and filled with mud. In consequence it must be very well drained and of a section sufficiently large to allow of the passage of a strong current of water in case of need.

In spite of all these precautions, there is in cold climates the danger of its being filled with ice, which makes working impossible. The systems of Holroyd by means of wood and fibre. Each segment is formed of two parallel bands of iron, R, separated by a non-magnetic body, such as wood (fig. 3).

Ordinarily, these segments do not communicate with the insulated conductor; each of them is fitted with two metallic boxes, K (fig. 4), firmly fixed below, and into which penetrate the branches of the principal conductor. These branches abut on pieces of soft iron, *n*, terminated by a piece, *m*, also of iron, jointed to the former, and connected with it besides by the spring, *r*.

The car is fitted with a powerful magnet, N, S (figs. 1 and 2), the poles of which magnetise by induction the two segments of the rail. These then attract the piece of iron, *m*, which closes a contact, bringing the segments into communication with the principal conductor.

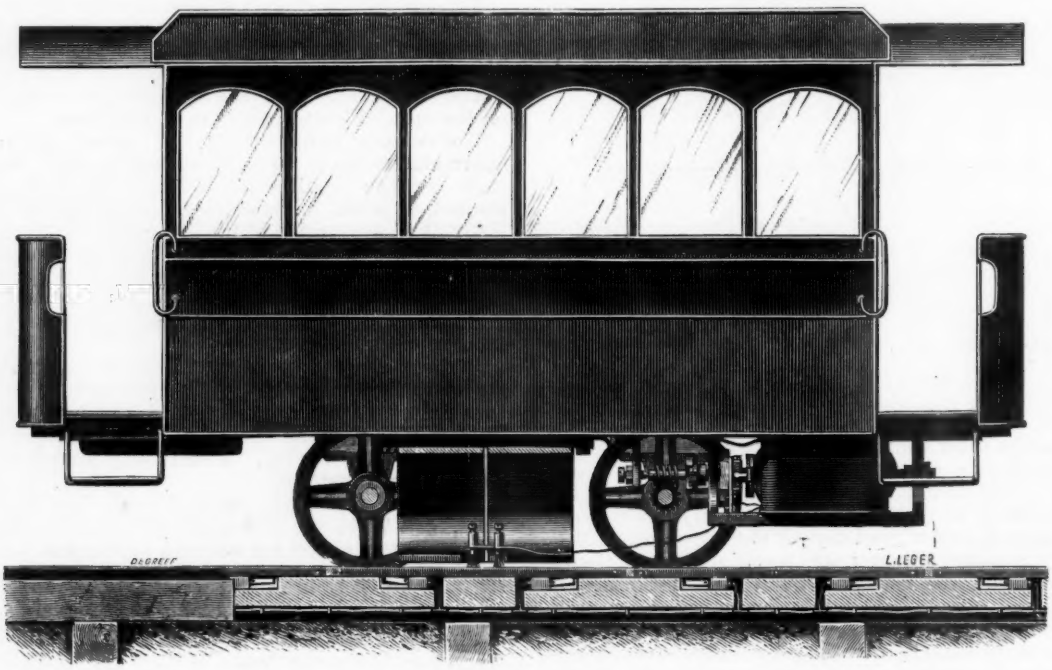


FIG. 1.

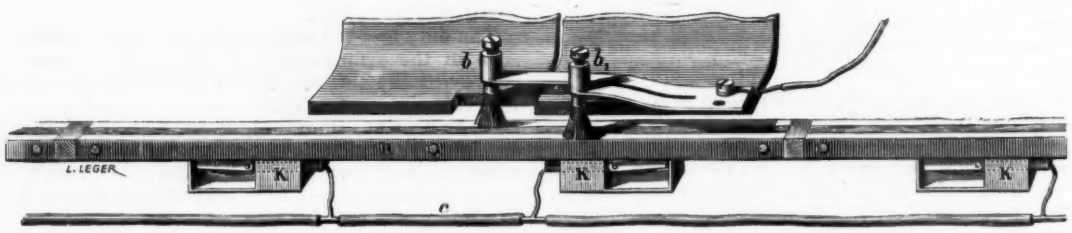


FIG. 2.

Smith, Siemens and Halske, Field, &c., belong to this class.

M. Pollak, by the invention of an ingenious arrangement, seems to have overcome most of these difficulties in a simple and practical manner.

M. Pollak also uses the rails as the first conductor, but the second conductor is completely insulated under the road, and does not communicate directly with the exterior.

The value of the system consists in the original manner by which the current passes from this insulated conductor into the moving car.

The current enters the car by means of a third rail placed in the middle of the track. Fig. 1 shows this arrangement in longitudinal section, and fig. 2 in transverse section. This rail, which should be made of soft iron, is divided into segments of about 3 to 4 metres in length, insulated from each other electrically Consequently at this moment the brushes playing on the central rail can collect the current.

When the car has passed the segments are demagnetised, the iron contacts fall back, and the communication between the segment and the principal conductor is broken.

The boxes, K, in which these contacts are made are closed hermetically and half filled with petroleum, which prevents moisture from attaching itself to the different parts.

The insulation of the boxes may be rendered practically perfect, so that losses from faulty insulation can take place only between the central segments placed beneath the car and the extreme rails on the surface of the earth. The loss, being limited to so trifling a length, is insignificant. The cost of laying the line is not high in comparison with the systems having underground channels; the central conductor being well insulated,

there is no occasion to make a drain or to interfere with the road. The chances of deterioration are very slight, as no delicate part is exposed.

The car always covers the segments which communicate with the underground conductor, so that there is neither danger of short-circuiting nor of giving shocks to men or horses traversing the road.

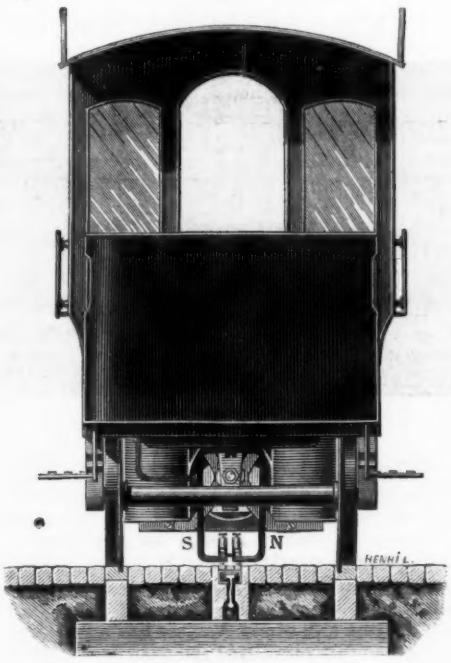


FIG. 3.

This system permits of the use of high potentials, and consequently effects a great reduction in the loss in the conductors. In fact, with a difference of potential of 500 volts 6 ampères suffice to furnish four electric horse power, which is more than enough for propelling an ordinary car.

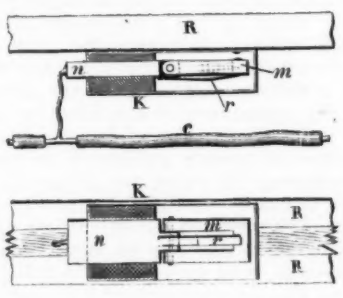


FIG. 4

The different figures accompanying the text refer to the reduced model of this tramway as it has been presented to and has worked before the International Society of Electricians.

In place of bringing the current by the central rail, and letting it return by the two others, it will often be advantageous to make use only of two rails properly so-called. One of them is divided into segments like the central rail just described while the other remains as it was. In this case, the wheels placed on one side of the car have to be insulated from their axles. The central rail is especially advantageous when it is required to convert a line already existing.

We have now merely to say a few words on the mechanical arrangements requisite for reducing the speed of the dynamo to that of the wheels of the car.

In order to employ transmissions by means of cog wheels, which are the most economical and compact, the inventor makes use of slowly-turning motors which revolve only about 500 times per minute, so that a single transmission by a cog wheel is sufficient to transmit the rotation from the dynamo to the wheels of the car, which at their normal speed make from 100 to 120 turns per minute (16 kilometres per hour with wheels of a diameter of 4 5 metre).

The use of toothed wheels would be impossible with a greater speed of rotation, on account of the deafening noise which they would produce. Moreover, the shocks would quickly destroy the teeth. On the other hand, transmissions by friction and by worm-gearing (Reckenzaun), if used at these great speeds, absorb much energy, up to 20 per cent., whilst transmission by cog wheels absorbs only 4 to 5 per cent. The advantages of the latter method are, therefore, as we see, considerable, on condition that we do not exceed a certain speed of rotation. Nevertheless, in the model, transmission by a wheel and worm-gearing has been employed.

The change in the speed of the car is effected, as far as possible, by changing the transmission by mechanical means, seeking to maintain the motor at its normal speed of rotation. Under these conditions the work developed by the motor remains the same, and the speed of the car varies according to the gradient of the line and the load. In this manner we avoid the regulation of speed by the motor, which is always attended by great changes in the current and which are thus unfavourable for both motors and conductors.

The entire system is at present under examination, and we shall, doubtless, when this is completed, have an opportunity to return to the technical details.

PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

MANY electrical engineers have felt the want of available information as to the various methods of testing and the use and calibration of the numerous instruments. The electrical student has abundant instructions as to the use of laboratory instruments, as they are fully described in text books; and articles and papers have been written on standardising instruments for very exact measurements with elaborate apparatus. The telegraph engineer has also his "Kempe," not to speak of many other hand books. Electrical engineering has brought into use large currents which are out of the ken of telegraph engineers; strong magnetic fields; and, in fact, a set of conditions altogether different from those of the laboratory or of the telegraph office. It will be here attempted to describe and discuss the various measurements that are necessary to the electrical engineer, that is to say, to write about electrical measurements in the workshop as opposed to mere laboratory work. The different measuring instruments in the market will be discussed somewhat critically, and their merits and faults, when they have any, will be pointed out. Such points as accuracy in ordinary use, portability or cheapness will be considered as of more importance than absolute accuracy under laboratory conditions. Long descriptions of things which are always described in text books will be avoided; and the reader will be spared the discussion of the best ways of coupling cells and the dissertation on shunts.

Mr. Gray's "Absolute Measurements in Electricity and Magnetism" (Macmillan, 3s. 6d.) covers some of the ground and is very well known; and since beginning these articles, Prof. Ayrton's able "Practical Electricity" (Cassell & Co., 7s. 6d.) has appeared. The writer finds much of what he intended to say said better by Prof. Ayrton, and will cut these parts down as far as is possible without making the articles incomplete.

Measurement of Resistances.

The measurement of the resistances that have generally to be tested, such as from 1 to 100 ohms, by means of the Wheatstone bridge, need not be discussed, but a few words may be said about resistance

boxes and bridges in common use. It is much to be regretted that some enterprising firm of electrical engineers does not take up the wholesale manufacture of such instruments as Wheatstone bridges, &c., as they are not at present made to suit the demand of the electrical engineer. Messrs. Woodhouse and Rawson are working in this direction, and it is to be hoped others will follow. The bridge is an instrument which can be made correct within a very small error, that is to say an error that is quite imperceptible in ordinary engineering work. Any slight error in the bridge is also very easily found out, as the bridge can always be checked against itself. The result is that the only bridges available are expensive instruments, costing from £20 to £30, considerable trouble and expense are gone to in the first place to adjust the coils with perfect accuracy, and an elaborate but unnecessary finish is indulged in to do justice to it. A bridge costing two or three pounds, suitable for ordinary installation work cannot be obtained. It is by no means intended to depreciate accuracy: an accurate instrument is better than an inaccurate one, other things being equal; but it would be absurd if a grocer could buy nothing cheaper than a chemical balance to weigh with, because scale makers found they were capable of very great accuracy and had plenty of room for unnecessary finish. Accurate bridges are required for such work as localising faults in telegraph lines, but rough resistance boxes right within say ½ per cent., would be good enough for ordinary work. As it is, an installing engineer who would not scruple to dispense with a voltmeter and judge the electromotive force by the look of the lamps, searches for ground contacts with a forty guinea bridge in conjunction with one defective Leclanché cell and a pivotted detector which sticks.

In many cases that occur in practice resistances may be taken by passing a fairly large current through whatever is to be measured and taking the volts and ampères.

In measuring the resistance of such things as magnet coils, the battery key must be pressed and kept down a moment, otherwise the self induction of the coil will send the light spot off the scale.

If the galvanometer is near the dynamos or in a place where the field varies while the resistance is being taken, considerable trouble will arise. The orthodox thing to do is to put an iron shield over the instrument. This cures the evil in text-books, but does not always work well in practice, perhaps because the coercitive force of the iron is too great to allow it to respond readily to the slight variations in the strength or direction of the magnetising force. No doubt the ordinary Thomson reflecting galvanometer is out of place in most workshops, and the d'Arsonval galvanometer should be used. This consists of a little coil of wire suspended, with each side in a very strong magnetic field. It is the same in principle as the Thomson siphon recorder, but the movement of the wire does not work a siphon, but is observed by means of a scale and mirror. This instrument is not much used in this country. It has the great advantage that it is not affected by slight changes in the external field. It has two drawbacks, viz., it cannot well be wound differentially, and it cannot be wound for very low resistances, as the circuit is made through the suspensions; these points do not concern us now.

It is often needed to test very low resistances such as that of a short piece of thick cable, or of the armature of a dynamo machine. The methods generally given in text-books for measuring very low resistances are not suitable. The difficulty in measuring very low resistances arises from the impossibility of making good contacts. If it were attempted to measure the resistance of an armature of about one-hundredth of an ohm, the resistances to be taken would only be a small fraction of the resistance of the wires from the bridge to the armature, and the fall of potential where these wires join the commutator would introduce an error as large as the desired reading. The least dirt on one of the plugs of the bridge would also give rise to errors.

The following method is a modification of an arrangement for measuring very low resistances, which appears to be due to Heaviside, who published it in 1873. It is sometimes credited to Tait and to Kirchhoff. The current is passed through the cable, or whatever is to be measured, and through a very low standard resistance which can be adjusted, and the fall of potential is compared by means of a differential galvanometer. In the diagram, fig. 1, A is a standard resistance, which is

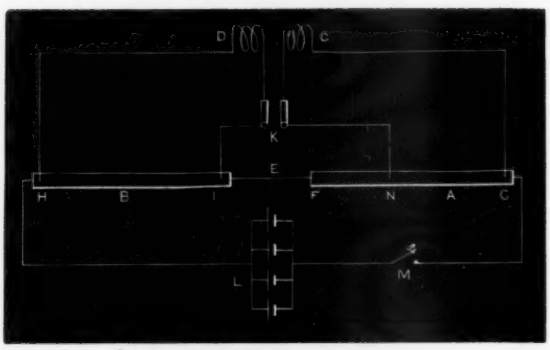


FIG. 1.

a rod of German silver, of somewhat higher resistance than the sample of cable. The resistance of A has been carefully taken between the two marks, F and G, and is, say, ·01 ohm. It will be explained how to make this bar presently. The bar, A, is graduated and divided up into 10ths, 100ths, &c. C is one coil of the galvanometer, which is of very low resistance. One wire, N, can be slid along A, so as to include any resistance less than ·01 ohm, B is the sample of cable, and D is the other coil of the galvanometer. The wires, H, I, are a foot or a yard apart, L is a battery of cells arranged to give a large current. A storage cell is suitable; M is the battery key, on pressing which a current is sent through A and B in series, and the double galvanometer key, K, is then pressed. N is then slid along A till the spot comes to zero. The fall of potential between G and N is then the same as between I and H, so the resistance of the cable per yard is read off along A. This measurement is not interfered with by any bad contacts between the wires, E and B or A, or between the battery wires and A or B. Instead of having a sliding contact at N, the wires may be fixed and the galvanometer circuits may have adjustable plug resistances. The sliding arrangement has the advantage of greater quickness in working and saves calculation. If resistance boxes were put in series with the coils of the galvanometer the resistances of the coils must be taken into account on each measurement, as, if they are so small in comparison with the resistances in series with them that they may be neglected, the arrangement is no longer sensitive.

If B is the armature of the dynamo, the wires for the main current are clamped to the commutator sections, and the pilot wires from the galvanometer, or feelers, are clamped to the same sections. The feelers must on no account be attached to the main current wires, as that would include the bad contacts over which there is a fall of potential. Bad contacts between the feelers and the segments of the commutator do not matter, as their resistance is small in comparison with the resistance of the galvanometer. The galvanometer should be tested for leakage from one coil to the other, as well as to see if the resistance of the coils is the same. To see if the instrument is truly differential, it is coupled up with the coils in series, and electricity passed through. If the spot moves it is not accurately differential. If it is differential the coils should be coupled in parallel, and the instrument tried again. If there is no deflection the coil resistances are equal. For measuring resistances in the manner just described, it is enough that there is no deflection when the coils are in parallel, as in that case any error due to the resistance being wrong is exactly balanced by an error by which the in-

strument is not differential. If the galvanometer is wrong, artificial resistance must be put in series with one coil. To test for leaks, a terminal of a battery is put on each coil, so that if the other two ends of coils were connected both coils would deflect the needle the same way. If there is any deflection the coils leak one to the other. Leaks from coils to frame should also be tested for.

Sir W. Thomson's method is described in most text-books. It may be adapted for use with the sliding standard, A. Fig 2 is a diagram of Sir W. Thomson's method. This method was originally for measuring the resistance of bars which could be joined together

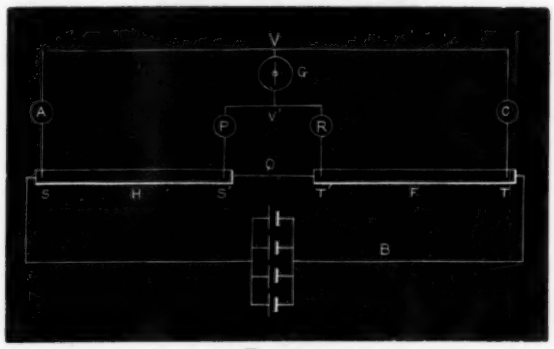


FIG. 2.

as shown, so that the fall of potential between S′ and T′ can be neglected. G is an ordinary galvanometer, and A, P, R, C are resistances which are high in comparison with the resistance between S and S′ and between T′ and T. If this arrangement is used for measuring dynamo-armatures, the resistance between S′ and T′ at once becomes important, as it most likely includes a pair of leads from the test room to the armature shop; any errors due to this must therefore be eliminated. To do this P is made equal to R, and A to C. The galvanometer then comes to zero, when H = F, and one feeder is slid up or down the graduated bar till there is no deflection. It is not necessary for R to be equal to C and P to A, what is really wanted is that $\frac{P}{A}$ should be equal to $\frac{R}{C}$. The arrangement can be made to multiply or divide as the ordinary bridge does. Thus if R = 10 P and C = 10 A, F will be equal to 10 H.

An ordinary post office bridge may be coupled up so as to compare two very low resistances by Thomson's method. In addition to the bridge and galvanometer a coil of insulated wire and a key are needed. The resistance of the coil is first measured in the ordinary way. The bridge is then coupled up as shown in fig. 3. The plug or strap that makes connection between Q and W is removed, and the galvanometer is inserted between the battery key, T and S. The measured coil, R, is inserted between S and G. The plugs are drawn between W and S so as to give a resistance equal to that of the coil, R, and the bridge proper has equal resistances drawn. N is then slid till the galvanometer is not deflected on pressing the key, T. By making R ten times or a tenth of the plug resistance, and altering the bridge to match, B can be compared with a tenth of or ten times A, and so on. Thomson's method admits of the use of a d'Arsonval galvanometer.

The standard rod, A, is got by first making a thick piece of wire one ohm between two marks on it. This is set up as in figure 1, and the resistance is inserted in the galvanometer coil that is in shunt to it, so that the resistance of the coil and resistance are ten times the resistance of the other coil. A much thicker rod is placed at B, and two marks are thus found including 0·1 ohm. This bar is then put in the place of A, and a new bar put as B, and marked to include 0·01 ohm. This bar is carefully checked along its length to make sure that the fall of potential is uniform; this is done by including short distances between the feeders, N and G, and balancing by putting H and I, close together. If it always takes the same distance between H and I, to balance B, is right. It is then marked off into 100 or 1,000 divisions corresponding to $\frac{1}{10000}$ and $\frac{1}{100000}$ of an ohm. If the bar is uneven, it can be measured every here and there along its length by

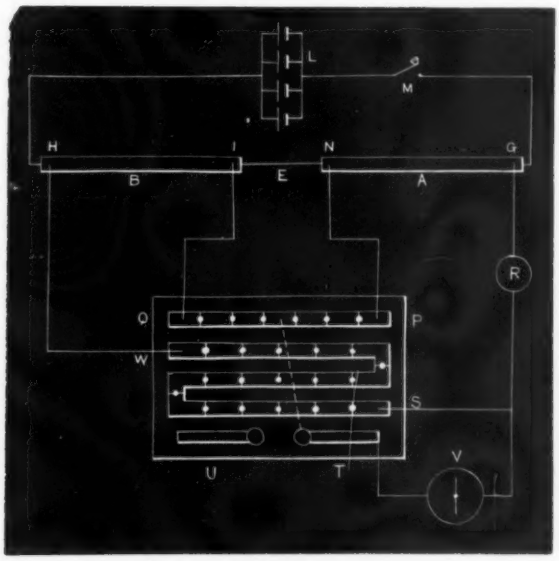


FIG. 3.

putting N and G back to the marks and altering the resistance in series with C. A number of marks can then be made on B, and the spaces between them can be divided off without any great error. If large currents are used to increase the sensitiveness of the arrangement, the various resistances must not be allowed to get hot, or corrections must be made for temperature.

(*To be continued.*)

SURFACE TENSION OF LIQUIDS UNDER THE INFLUENCE OF THE ELECTRIC CURRENT.

WHILE experimenting some time ago on the mechanical effects of an electrical current I (Edward Blakeney in the *Electrical World*) constructed an instrument which exhibited a very curious and interesting phenomenon. I have never seen anything of the kind elsewhere, and, although I was much interested, I have never had the time to fully investigate it.

I shall be glad to describe the experiment to the readers of the *Electrical World* in the hope that it will be of interest. Perhaps some of your readers may find a useful application for the principle.

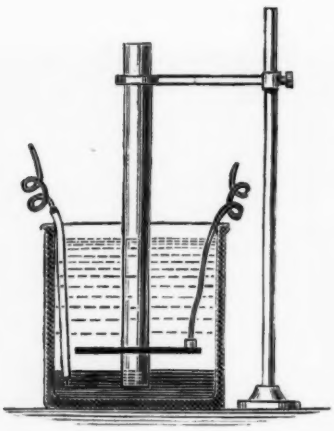
In the bottom of a small glass tumbler (see accompanying sketch) is placed about one-eighth inch of mercury. A glass tube of half-inch internal diameter is suspended vertically in the centre of the tumbler, with its lower end dipping into the mercury, but not quite touching the bottom of the tumbler.

A punctured copper disc is slid down over the tube. This disc serves as one of the electrodes, the mercury serves as the other. The tumbler is then filled with water.

When, now, a battery of two or three cells is connected to the terminals, the mercury is seen to be somewhat agitated, and at the same time the water begins to rise in the tube. If the latter be not too high the water at last overflows and the action continues, but if the tube be over two or three inches high there is a point reached where the water will rise no higher. This, undoubtedly, is the point of equi-

librium between the weight of the water and the force which is acting upon it.

It will be noticed that, in order to ascend the tube, the water must first find its way under the mercury. So far as I investigated the matter it appeared to me that



the mercury took on a sort of vortex motion, drawing the water down at the sides and expelling it in the centre, thus filling the tube.

When the action is continuous, the instrument might properly be called a vortex electrical pump.

GAS LIGHTING BY ELECTRICITY.

A SYSTEM of gas lighting by electricity has been introduced by Messrs. Woodhouse and Rawson, of 11, Queen Victoria Street, E.C. Gas can be turned on, lit and turned off, from any convenient position irrespective of where the gas fittings are placed. The principle of the attachments is analogous to that of the portable electric gas lighter now so well known, *i.e.*, the gas is lighted by an electric spark; but the general arrangements are for permanent fittings, as will be seen by the following brief descriptions of some of the numerous applications.

The first form of lighter named in Messrs. Woodhouse and Rawson's new list, a copy of which we have before us, is the "Automatic," by means of which the gas may be turned on, lighted and turned off by simply pushing a push conveniently placed either near or at a distance. The mechanism is exceedingly simple, being wholly enclosed in a polished brass shell, giving it a very neat and compact appearance, as will be seen by our illustration (fig. 1), which is full size. This arrangement is most suitable for theatres or public halls, where, as a rule, the chandeliers or gas brackets

FIG. 1

are high up, or for invalids' rooms, halls or staircases. It is impossible to turn on the gas without lighting it, so that any danger from this source is prevented.

The next form in their list is that called the "Simple Hand Lighter." It contains no stop cock, but by pulling a pendant chain the gas is lighted after it is turned on by the tap in the ordinary way. It is the same in appearance as the ratchet burner (fig. 2), but by the last-mentioned the gas is turned on as well as lighted by the pulling of the chain and turned off by every alternate pull. Various types of these are made to suit the particular situations for which they are required.

Fig. 3 illustrates the "Thumb Cock Burner" which is turned on and lit simply by means of an ordinary tap. By means of the "Vibrating Lighter" the gas may be turned on and lighted simultaneously by means of a switch or press button placed at any distance from the chandelier that may be desired. There are a number of other forms of burners which may be operated in a similar manner, such as the "Argand Candle," &c. The "Automatic," described above, is also applied in the form of a ring burner (fig. 4), which is designed for multiple lighting in churches, theatres, halls and shops. The ring may be of any size, and may contain fron 30 to 40 gas tips, say 2 inches apart.

FIG. 2.

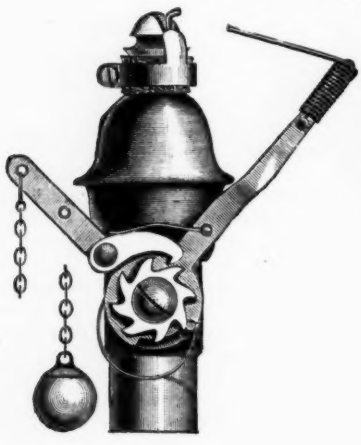


FIG. 3.

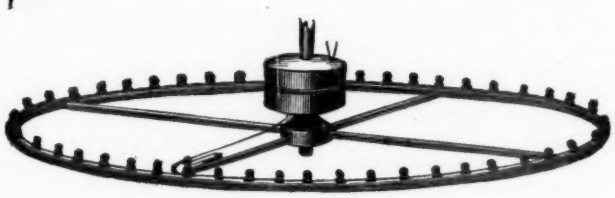


FIG. 4.

After one jet is automatically lighted the rest ignite by contagion. A special form is made for billiard rooms, and as the dropping of grease from tapers, &c., and burning ends of matches on cloths of tables is an objection which it has for a long time been desired to remove, we have little doubt that these burners will receive a warm welcome in the billiard world.

The general installation work is much of the same character as with electric bells, and in houses where these bells exist, it is very little extra work to fix the lighters, as the same batteries may be used. Messrs. Woodhouse and Rawson have a special staff of workmen for this class of work, which is somewhat technical in its nature, and must be done with nicety to secure satisfactory results.

We would remark that Mr. Lane-Fox, a few years ago (ELECTRICAL REVIEW, December 15th, 1877), invented a system of turning gas on and off and lighting it by means of electricity, and the apparatus was actually employed in Pall Mall for a time.

REVIEW.

Factory Accounts, their Principles and Practice. By EMILE GARCKE and J. M. FELLS. London: Crosby, Lockwood & Co.

This work is the result of great observation on the part of the authors and may more properly be described as a dissertation on factory accounts than a method of keeping accounts recommended for adoption; being such as, judging from the perusal of the work, appears to be a copy, with enlargements and modifications, of a system of accounts in use at some factory or works with which the authors are acquainted.

We may premise that first, in regard to factory accounts, one main object is to produce such a system as may be most universally applied to the method in existence in the various factories to be benefitted, so as to disturb as little as may be the conditions found in the specific circumstances of each factory. This the work in question appears to accomplish, for the system can be easily applied and is, in fact, such as in the experience of many accountants is in vogue in many works with which they as auditors are familiar, and we will go so far as to say that the factory the accounts of which are kept on a plan wide of that which is here advocated is far from being efficient in its bookkeeping.

Still it is well to consider again the importance of producing such a system of keeping factory accounts as can be easily carried on by the existing staff, so that it may not be necessary to increase the expenses of the office, which, it must be remembered, is non-productive.

Again, it must not be lost sight of that it is not expedient to complicate the necessary entry of business transactions by increasing the number of books. One is struck by the array of books (twenty-two) that are recommended in the work before us to be used in order that business transactions may be properly shown.

With reference to the system set out as advisable for properly getting together the various items which make up "wages" so that they may be collected for use in the prime cost book, this requires apparently eight books, besides sheets, in order that the amount of work done and the money paid for the same in day work, piece work, and over time, both of foremen and workmen, &c., may be shown, and it would appear to require more clerical labour than an employer would feel justified in expending for this purpose. We may ask why the abstract of wages should not be in the wages book at the end of each week instead of being a separate book.

The storekeeper's and stockkeeper's books are important, and if worked on the system here set forth, albeit cumbrous, will, in the multiplicity of entries and checking from one department to the other, tend to reduce the opportunity for dishonesty to a minimum.

Is it to be understood that the book kept by the storekeeper is a store book to contain entries of all goods purchased or manufactured in the nature of stores, and that when these are distributed for working up the entries on the other side of the book to close each transaction or distribution, and with or without prices?

Although there are 45 specimens of rulings, there is in no case an example given of any entry of an article to illustrate the manner of such entry. These diagrams require careful study to be understood.

The stockkeeper's book is more important still, as the stores have a certain amount of wages apparently spent upon them to convert them into stock, and so they have largely, perhaps doubly, increased in value; therefore it appears that the stock book or ledger would contain the prices of the various goods at cost (material and wages), and the stores book would contain the value of the goods in the rough.

We think that if these books were ruled properly there would not be so many of them needed as here appears; moreover, the explanations are not quite so lucid as they might be. Our remarks as to the multiplication of books we here reiterate.

We also think that the office should be the centre of supply, and that all invoices should be entered in the invoice book, with the prices charged, and the goods checked therewith at the stores when the items are entered in the proper place in the stores book.

It appears by the chapter on Stock that it is intended that each sale should be individually credited in the trading account; we should think that monthly totals of the day book or journal would suffice.

We do not agree with the idea expressed that the stock book should be taken as evidence that the stock is in hand, without examination, but it should be checked from time to time, frequently, or certain classes of goods taken arbitrarily. We should be inclined to distrust a balance sheet admittedly prepared without due inquiry as to the existence of items shown therein as assets.

It appears to us that the system set forth for calculation deteriorations is too complicated for universal adoption, especially when it is considered that in machinery and tools the repairs done virtually renew the tool.

With the exceptions we have stated, we cordially accept the work as one of theoretical and practical value. Although, as we have before said, any practical accountant could, and does, in the factories the accounts of which he audits, recommend alterations and additions in the mode of keeping the books as neglect or ignorance need, these recommendations would, we think, more readily be adopted and carried out after a perusal and study, on the part of principals, of these pages. A great difficulty is found in the unreadiness of employers to alter their accepted system, in the fear of increased expense in the non-productive staff, and these matters are put in the background "till things are better," when it may be that a properly drawn "profit and loss account" would reveal improvement upon a close examination of figures. Especially in wages a leak may be found by a more careful oversight and comparison of the value of an article in an unfinished and finished state.

We do not discover any method of accounts recommended where founding is carried out in connection with the factory, as would be the case with large works, to bring the cost of casting, trimming, and fuel, &c., into the prime cost book, as in the manufacture of machinery, gear, and tools; but to all engaged in the supervision of factory accounts a study of this work can but prove of advantage.

Gas and Electricity.—Several of the French gas companies, we learn, have clubbed their funds and instituted an experimental electrical laboratory, with the view of ascertaining whether they ought to enter upon the supply of the electric light. The director is the well-known electrician, M. Monnier.

THE MANCHESTER ROYAL JUBILEE EXHIBITION.

THIS exhibition, which will be opened on Tuesday next by the Prince and Princess of Wales, has now arrived at a state of such advanced completion as to deserve some notice. The structure itself is practically complete, some minor details being alone wanted to finish it, so that there can be nothing now due to the construction of the building which will in any way interfere with the success of the opening ceremony.

As regards the exhibits themselves, there can be no question whatever that harmony and order will prevail long before the opening day. Unfortunately too much laxity has been allowed to the exhibitor in previous exhibitions, and there has been great want of punctuality in the delivery of goods, after the exhibition has been opened being considered quite early enough to send them in. At the present exhibition the general manager, Mr. Lee Bapty, had determined that the exhibits should be in the building in time, and stringent instructions were issued to that effect. Whilst every convenience was given to exhibitors by means of numerous entrances, and easy transit to any point by an excellent system of temporary tramway laid down, it was determined that after a certain date no goods would be admitted, and that the various extra entrances should be closed. The date for admission has now passed, and we notice that these entrances have been bricked up, and in walking through the exhibition, we find that the excellent arrangements of Mr. Lee Bapty have produced the result that the stands and allotted places are all occupied, and that the exhibitors have now completed the arrangement of their various articles.

As regards the electrical and kindred exhibits, we are promised a fair show—dynamos and motors in motion and other exhibits of the usual character; but of these we shall describe in detail, later on, such as have special interest.

Several trials of the various portions of the electric lighting were made last week, but from various causes the first reliable experiments were not made until Monday last, when the Exhibition and its arrangements were thrown open to the inspection of the Press. On that occasion some definite runs were made with both the arc and incandescent electric lighting plant, and a very successful exhibit was obtained, especially so far as the system of incandescent lighting was concerned. Steam was got up in all the ten Galloway boilers, and as the whole of the dynamos and engines for the incandescent plant were ready, a good run was obtained and the incandescent lighting was eminently successful. The arc lighting was, however, only partially carried out.

The incandescent light installation for the various sections of the Exhibition was entrusted in its entirety to the Manchester and District Edison Electric Light Company, and under the superintendence of its manager, Mr. J. R. Williamson, the whole of the work has been carried out. This installation is the most important of any in the incandescent system carried out up to the present time. The portions of the building lighted in this manner are the Fine Art Galleries, the Palm House, a dining room, and the Old Manchester and Salford sections. Of these the Fine Art Galleries are the most important. These galleries consist of fourteen rooms, and when completed will contain a collection of pictures unequalled. These rooms are of the same width, but five are slightly deeper than the remainder, having nine principals instead of seven as in all the rest. The lamps, which are of the Edison-Swan type, 100 volts ·6 ampère, fixed in bayonet sockets, are suspended from casing placed immediately under the principals. There are 15 lamps to each principal, and above each lamp is fixed a 5-inch opal shade. There are therefore 135 lamps in each of the five rooms, and 105 in each of the other rooms; this gives a grand total of 1,620 lamps. These galleries are about 300 yards from the dynamos and are fed by eight heavy mains, four ceasing at the middle whilst the other four are continued to the end. These mains are cleated to the outside walls of the galleries, and connections are made by branch cable through each of the galleries.

The circuits are so arranged that in each room five of the principals are fed from one pair of mains, whilst the intermediate or alternate principals are fed from the other pair of mains, the arrangement being reversed in the next room, &c., so that the failure of any one main will not throw the galleries into darkness. The height of the lamps is about 18 feet from the floor. Precautions have been taken against any accidents from heating, &c., and safety fuses are attached where necessary, double pole cut-outs being also provided to every principal.

In the Palm House, the arrangements, when completed, will have a very pretty effect, but the floral decorations are not quite ready and the exact number of lamps is not yet decided on. As at present arranged, the lamps will be of 8 C.P., but on the trial on Monday last, the lamps, of which over 400 were fixed, were of 16 candle-power, the light being very effective. The lamps are hung in clusters of three, suspended by a double wire ruby silk covered, from the roof; above the lamp is a large ruby coloured globe. At each end of the Palm House were crescents of lamps, which had a pretty effect.

In the picturesque section of Old Manchester and Salford, the total number of lights has not yet been fixed, but on Monday last, nearly 200 were in position and lighted. Every arrangement as regards connection, switches, &c., has been made for the remainder, and when all are alight in the various rooms throughout the many quaint houses, the appearance of the streets will be decidedly pleasing, though presenting a distinct anachronism. The distances of the several sections we have named from the dynamo room—the Fine Art Galleries being one-fifth of a mile, and Old Manchester and Salford, one quarter of a mile—and the very large number of lamps required, have necessitated the employment of exceptionally heavy conducting wires, formed into cables. These cables have been made in various sizes according to the requirements of the several sections, but they represent a total length of cable exceeding *nine* miles, whilst the bare weight of the copper alone required for the conductors of these cables, is calculated to be very nearly *ten tons*. The whole of the conducting wires, including mains, branches, and leads for the incandescent lighting of the above sections have been manufactured and supplied by Messrs. Walter T. Glover & Co., of Salford, Manchester. Where the mains pass underground in the approach and at one or two other points they have been placed in wooden troughing and well pitched and compounded. The whole of the wiring and fixing the lamps, &c., for the incandescent lighting has been carried out under the personal direction of Mr. Henry Taffs of the Manchester Edison Company, who has had entire charge of the work from the commencement.

The mains from the fine art galleries are led on to a massive switchboard, mounted on ebonised slate, in the dynamo room, with which are connected the dynamos lent by Messrs. Mather & Platt for the exhibition. The mains from the Palm House and Old Manchester and Salford are led on to another switchboard of similar construction in connection with the dynamos supplied by the Manchester and District Edison Company. These switchboards are very fine and massive, and form quite ornaments to the dynamo house; they have been specially manufactured by Messrs. C. L. Baker & Co., of Manchester.

Our description of the various dynamos for the incandescent lighting, of the engines which are employed to drive them, and also of the switchboards and connections, we must defer until after the opening of the exhibition (May 3rd), when we shall be able to complete the necessary details of the sections mentioned. It is, however, necessary to say that the whole of the wires are finished and have been thoroughly tested.

With the exception of the arc lights required for

the "fairy" fountains, and two in Old Manchester, the whole of the lighting by arc lamps of the interior of the buildings and of the botanical gardens has been carried out by the Anglo-American Brush Corporation under the direction of Mr. Raworth, the company's superintending engineer. There are in all 26 dynamos employed, of the following types—

8 No. 8	dynamos,	equal to	35 lights,
8 No. 7	"	"	15 "
10 No. 7L	"	"	25 "

giving a total output of 650 lamps of 2,000 C.P. each. These dynamos have been employed at previous exhibitions, beginning with that at Paris in 1880 and the Crystal Palace in 1882. Some of them were used at the various exhibitions held at South Kensington, and some at last year's exhibition at Liverpool; in fact, all the dynamos now at Manchester have been in frequent use. The Brush lamps are of the usual circular type with new winding, and burn 11 mm. Brush carbons. They are worked with a current of 10 ampères and 48 volts.

The twenty-six circuits are so sub-divided and arranged that the failure of any circuit will only have the effect of reducing the light to a small extent. In the machinery annexe there are 130 lamps and 40 in the "silent" annexe, on eight circuits. In the West Nave, Irish and Chemical Sections, 118 lamps have been distributed by means of four circuits. In the centre of the "dome," suspended from the roof, there is a circle of eight lamps, whilst around the outer circle of the dome 20 lamps are distributed. In the East Nave, Music Room and Chemical Section, there have been fixed 125 lamps in four circuits. In the refreshment and dining rooms near the Irish Section there are 30 lamps in two circuits, and in the approach 30 lamps also in two circuits; these are placed right and left of the centre, and when lighted give an excellent effect. In the upper grounds of the Botanical Gardens there are fixed six large masts, each carrying three lamps, whilst there are 26 lamps placed amongst the trees and at other points. In the lower grounds there are placed six masts, each containing two lamps. This brings up the total to 557 lamps at present arranged for, but there will be some more fixed in the grounds, and also on a special circuit which is termed the "police" or "safety" circuit. This circuit contains a lamp placed in each of the different rooms or sections throughout the building, so that should anything happen to all the circuits, or a light be required over the whole place independent of a general lighting up, this circuit can be turned on.

The lamps are suspended with ropes, which might have been of less diameter, giving an improved appearance, and the cables are of double rubber and gutta percha insulation, and are run through conical porcelain insulators. The mains from the dynamo room are carried in a very neat and workmanlike manner by means of small porcelain insulators, through which they are threaded (these insulators are formed like grooved dead-eyes for a rope.) The insulators are held by an iron hook which is screwed into an arm or any wooden beam or partition. These hooks when made red hot are slightly opened, the insulator is dropped in, and when the iron cools the insulator is firmly gripped. This arrangement is due to Mr. Court, of the Anglo-American Company, who has had the entire charge of the arrangements from the commencement, and under whose personal direction the entire work has been satisfactorily carried out. The wires and cables have been in use—that is, a large portion of them—at previous exhibitions, but a quantity of new wire has been supplied by Messrs. W. T. Glover & Co., of Salford, from whom also a large portion of the old cables had been obtained for the previous exhibitions.

Several runs of the dynamos and the various circuits have been made at different times, but owing to the boiler feed not being right many of these runs were of short duration. During the latter part of last week, the pumps having been fixed, more lengthy runs were obtained, and workmen were enabled to work until midnight by aid of the lamps. On Monday night, however, as we before mentioned, a more extended run was attempted, but, unfortunately, it was not attended with the expected success, as it was impossible from the kind of driving belts used (engine to counter-shafting) to obtain the necessary power. The number of circuits having been reduced a more even power was obtained, and the full advantage of the light was clearly shown in the dome and also in the "approach." The faults in the driving will doubtless be at once remedied, and before the opening day there is no doubt but that a successful run with all the lamps in operation will take place.

The original programme of the arrangements designed by the electrician to the exhibition, Mr. William Bryson, has been almost faithfully adhered to (see our issue January 21st last), and the result fully shows the advantage of the scheme as planned, reflecting the greatest credit on Mr. Bryson, whose unceasing energy, perseverance, and constant attention have undoubtedly contributed in a very marked degree to make the electric lighting of this exhibition a most important and attractive feature in its success.

MINERS' ELECTRIC SAFETY LAMPS.

IN the *Newcastle Daily Chronicle* of Tuesday, there appeared an article on "The Exhibition and the Miners' Electric Safety Lamp," "by a Coal Hewer." The very practical remarks which the article contains, by one who should be an authority on the subject of miners' lamps, are of so interesting a character that we reproduce them for the benefit of our readers.

"In the opinion of miners, a Royal Exhibition held in Newcastle in jubilee year, illuminated by electricity, and containing, amongst its exhibits a mine as like a real mine as an artificial mine can well be, cannot be complete without having among its exhibits the miners' electric safety lamp. At the present moment, the question of providing an efficient safety lamp is before the public and the Legislature, and inventors are endeavouring to produce a lamp which shall fulfil all the requisite conditions. Although the electric safety lamp was invented in Newcastle, scarcely a miner in the two Northern counties knows anything about it except what he has gleaned from the newspapers, and from knowledge obtained in this way no one could undertake to say that the lamp is, on the whole, superior to some of the lamps now in use. But even though the superiority of the lamp were admitted by those who have examined it, yet the expense to coal-owners of introducing a new lamp into their mines is so great that some pressure is required to effect the change, and this pressure cannot be produced unless the public generally, or, at all events, the miners generally, are prepared to testify to the superiority of the lamp. But so much was heard of the lamp, of its weight, its illuminating power, and above all of the firedamp indicator which is attached to it, that apart from all considerations of its superiority, the lamp itself would prove an object of great interest to miners, and could not fail to contribute to the success of the Exhibition. If placed in the mine, the lamp would be examined by practical miners with the thoroughness of an examination in a working coal face. It should, of course, be placed in a position where it can be moved about, as its portability is a question on which there is some difference of opinion, and which must be settled before any movement in favour of its introduction can be started. So small would be the expense of exhibiting the lamp, that that question scarcely requires discussion. The committee of management and the manufacturers of the lamp are actuated by higher motives than that of profit.

"One who looks to the electric safety lamp for the solution of the most difficult and most pressing of mining problems, may be pardoned for pressing this suggestion so strongly. Miners regard the introduction into a mine of a safety lamp of any kind with suspicion. They

think the lamp is too often a substitute for ventilation, and I have heard experienced and intelligent miners say that if a lamp were invented which would burn without air, there would then be an end to ventilation of mines. It is well known that Welsh coalowners were hampered in their efforts to introduce the Musseler lamp by the prejudice of the miners against that lamp. The only objection, however, which can, so far as I am able to judge, be urged by miners against the electric lamp is that of its weight. Certainly a lamp of 6 or 7 lbs. weight cannot be carried about a mine all day by a man, much less a boy; and it is hardly necessary to say that the coal is conveyed from the coal face to the shaft mostly by boys. But even a lamp of this weight is not too heavy to be carried into the coal face, where it could be used all day without the least expenditure of physical energy, or at all events, without the expenditure of more than that required to shift it about occasionally. The superiority of the lamp over other lamps and candles in point of illuminating power would cause an increase in the efficiency of the miners, which would, after a while, fully compensate for the cost of introducing the lamp. An increase in safety, or rather a decrease in the number of accidents from falls of stone and coal would result from the increase of light. The injury to life and limb from 'falls' is much greater than the injury inflicted by explosions, and a miner's power to cope with dangers of the roof and sides increase, with an increase in the quantity of light at his disposal. But it is the connection of the firedamp indicator with the electric safety lamp which constitutes the chief merit of that lamp. This instrument is destined to play an important part in the mining of the future. It has yet to tell how much firedamp is generated in any part of a mine, to furnish data to enable miners to judge of the adequacy of the ventilation. A great deal has been heard of firedamp indicators, but few, even miners, know anything of the construction of that instrument. Could a small supply of gas be kept at hand in the Exhibition so that this instrument could, at the request of a few practical miners, be brought into use, the electric lamp would by no means form an insignificant feature of the Exhibition."

NOTES.

Electric Lighting in Yorkshire Mills.—The Woodhouse and Rawson Contract and Maintenance Company has recently completed an installation of electric lighting at the works of Messrs. Campbell and Harrison, wool combers, Upper Castle Street, Bowling. There are about 400 incandescent lamps distributed over the premises. To supply the electric current for these there are four Mather and Platt dynamos, three of which are used for lighting direct and one for the charging of a small storage battery, consisting of 26 E.P.S. cells. But as the object aimed at in designing the installation has been to render a break-down, even of a temporary character, as nearly as may be impossible, the dynamos laid down have a collective capacity equal to carrying over 800 lamps. The power for driving the dynamos is supplied by one of either of the two main engines—a beam engine and a compound horizontal condensing engine—used for driving the works.

The Miners' Conference.—At the meeting of the Miners' Conference at Manchester last week, amendments were suggested for embodiment in the Mines Regulation Act to the effect that safety lamps should be tested by a competent person before the men descended the pit shaft, and that dangerous mines should not be worked day and night.

Monument to Galileo.—A monument was last week unveiled to the memory of Galileo in the Pincio at Rome.

Practical Electrical Measurement. — Our readers will note with satisfaction that in this issue Mr. J. Swinburne commences a series of papers of the greatest importance to all practical electricians. The writer's extensive knowledge of his subject is a sufficient guarantee that it will receive judicious and ample treatment.

The Singapore, Straits Settlements and Siam Electrical Company, Limited.—This company has been formed, with a capital of £60,000 in £5 shares, to acquire and work an electric lighting concession, dated September 29th, 1885, granted by the Municipal Commissioners of Singapore to Mr. Edward John Wells, civil engineer, of Singapore and the Straits Settlements, and for carrying out electrical work generally, including the installation of telephones and telegraphs in the far East. The concession is for lighting by electricity an area of about 1½ square miles. Upon its successful execution the Commissioners will, it is stated, be prepared to grant a general concession for lighting the whole of the district of Singapore. Tenders were invited two years ago for the lighting by electricity of the Tanjong Pagan Docks, which lie within the district of Singapore. No tender was then accepted, but it is understood that the work, which is expected to cost about £4,000, has been only temporarily deferred. Mr. Wells, the vendor, has already an extensive business in Singapore, and he has received applications for lighting upwards of 200 native residences, public buildings and hotels in Singapore within the district covered by the concession which he already holds; he has, moreover, arranged with the Sultan of Johore to supply the palace and the city of Johore with the electric light, so that it will be seen there is already in existence the nucleus of a valuable business. The Commissioners of Penang, it is further stated, are prepared, upon the successful lighting of Singapore, to favourably entertain a proposal for a concession for lighting Penang. Other work has been treated for by Mr. Wells in Siam, and there is little doubt that a very extensive and remunerative field awaits the operations of the Singapore, Straits Settlements and Siam Company, which we wish every success. The directors are Colonel Sir Francis de Winton, K.C.M.G., Mr. H. Seymour Foster, and Mr. F. L. Rawson (of Woodhouse & Rawson).

Electric Lighting in Scotland.—The electric lighting work which is done in Scotland is still chiefly in connection with shipping, though at the present moment arrangements are in progress for some important installations, such as those of the Bazaar, City Hall and new Municipal Buildings, Glasgow, the *Scotsman* office, Edinburgh, and later on the Glasgow Exhibition of 1888. Mr. J. D. F. Andrews, of Glasgow, is constructing a 500 light machine for the *Scotsman* office, but it is not yet decided who is to have the contract for the Glasgow public buildings. In ship lighting good business is being done by Glasgow and Edinburgh firms. Mr. Andrews is at present engaged upon a large steamer intended for Canadian coasting purposes, in which there will be about 135 lights, seven nickel-plated pendants for the saloon (which are constructed for both electric light and oil) being very handsome fittings. The engine room is wired on what Mr. Andrews calls his sheathed wire and joint box system, which is contrived to stand any amount of wetting and drying, which the ordinary wood casing will not. The same gentleman is also fitting up several oil vessels, including a new one built by Messrs. Armstrong, Mitchell & Co., and another in course of alteration by Messrs. Swan & Hunter, the new plan of wiring being adopted in all. A new passenger line, established by the Carron Company, commences running on the 3rd of May between Grangemouth and London with through bookings from Glasgow. Two splendidly-equipped steamers have been built specially for this service, and have been fitted for electric light by Messrs. W. Harvie & Co., of Glasgow, who have put in Phœnix dynamos driven by Chandler engines.

There are 107 lights in each boat. At the ship yard of Messrs. W. Denny & Co., Dumbarton, the firm has established an electrical department which, under the management of Mr. Smiley, is assuming considerable proportions and importance. Their own works are very extensive, consisting of two distinct establishments, the ship yard and the engine works, a mile apart, and the lighting of these is of itself a pretty extensive installation; but provision is also made for any demand likely to arise for the lighting of ships built by the firm. The stores are on an extensive scale, a great variety of fittings and requisites of every kind being kept ready for immediate use. At present important improvements are in progress, including a new accumulator house and new rooms and laboratories for the electrician. A novel kind of steamer, recently built at Leith for night service between Hong Kong and Canton, and its Chinese crew, are just now the subject of considerable local curiosity. It has three decks, has sleeping accommodation for 3,000 passengers, and is said to look more like Noah's Ark than anything else. This ship, which is called the *Fatshan*, is fitted throughout with electric light.

Electric Lighting in Dundalk.—Mr. C. C. MacCarthy has supplied at his own expense and risk the necessary machinery for lighting Dundalk, a town of 1,350 inhabitants, with arc lamps, and he has also contracted to supply the light for three years at a cost of £400 per annum, which is at the rate of £16 13s. 4d. per lamp. The plant consists of a 30 H.P. nominal horizontal condensing steam-engine and Cornish boiler, manufactured in Dundalk. Three series dynamos, giving 16 to 17 ampères at 620 volts, are coupled together, bringing the total E.M.F. to over 1,800 volts, and these supply the current to 24 arc lamps of the new simplex pattern. The circuit extends over 6½ miles, and is formed of No. 8 B.W.G. bare copper wire, suspended overhead on poles properly insulated. The lamps, which are double ones, require from 50 to 60 volts each with the current above mentioned, and they then give a light stated to be over 3,000 candle-power. At the end of the contract the Town Council may give up the lighting if thought desirable, so it will be seen that Mr. MacCarthy has engaged in an enterprise requiring no little confidence in the economy of electricity. The price of £16 13s. 4d. per lamp per annum appears to us to be marvellously cheap, yet the contractor says, cheerfully, it pays! Much credit is due to Mr. MacCarthy for his spirited enterprise, which he appears to have carried out without any assistance from the Town Commissioners, who have given him the contract, mainly, we imagine, because his price was £60 less than the gas tender, which was for 200 lamps of 15 candle-power each. We hope that the particulars of this installation—the experimental trials of which with some of the lamps have been satisfactorily carried out—will become widely known.

Gas Lighting and Electricity at Bradford.—We have heard a good deal of late about the progress of the electric light in the Bradford district, says the *Gas World*, and although we do not meanwhile fear its competition with gas, the corporation should consider whether the time has not now arrived when the long-continued tax upon light should be abolished. During the debate in the council last Tuesday, a case was mentioned where the reduction of 3d. per thousand cubic feet in the price of gas meant a saving to one firm of £400 a year, and had this reduction swept away the entire profits, and necessitated the imposition of a 4d. rate, the amount the firm would have been called on to pay would have been only £166. This clearly shows that the firm contributes more to rates through using gas than it would be called upon to do were gas sold as near cost price as possible and a tax substituted. In Bradford, as elsewhere, the gas consumer has been a rich and an easy cow to milk, and so long as he remains quiescent, the process of milking will continue; but in view of probable competition by electricity, apart altogether from considerations of fair dealing, it is time that the system of levying profits on the sale of gas should be abolished by corporations.

Electric Light at Leamington.—The Leamington Town Council has accepted the following tender of the Midland Electric Light and Power Company:—"To supply and fix 55 new single standards, 12 new three-light standards, and to alter 92 existing lamp posts for the sum of £542 10s. (such new and altered standards remaining the property of the corporation), and, further, to light 183 lamps of 16 min. candle-power each, under the supervision of the borough surveyor, and during the hours the gas has been lighted during the past year, it being understood that 100 lamps only are to be maintained alight after 11 p.m. for the sum of £385 per annum, paid quarterly. This sum is to include renewal of lamps, cleaning, lighting, and extinguishing, and keeping in repair, but not repainting the lamp posts."

Electric Lighting of a Candle Factory.—The large candle manufactory at Gouda, Holland, the *Gas World* states, is to be lighted by arc and glow lamps in June next. As the manufactory has hitherto used 6,300,000 cubic feet of gas per annum, the installation is looked forward to with lively interest by the municipality, which becomes owner of the gasworks in October next.

The Telephone between Paris and Brussels.—An additional convention between the French and Belgian Governments has been signed, concerning the working of the telephonic line from Paris to Brussels. Monthly subscriptions, varying from 100 francs for 10 minutes to 600 francs for 80 minutes, will be accepted. For the intermediate periods, the rate of increase in the amount of the subscription is 100 francs for every 10 minutes, or fraction of 10 minutes, up to 40 minutes, and 50 francs for every 10 minutes, or fraction thereof, between 40 and 80 minutes.

Long Distance Telephony.—The *Financial News* thinks very few Londoners are aware that genuine trunk lines—money-earning, time-saving appliances, and not mere toys—exist in the north, "the true home of successful English telephony," and proceeds to inform them that miles of them are now working in Lancashire, Cheshire, Yorkshire, Northumberland and various parts of Scotland. If London were joined on to the extensive circuits now operating in the north, it asserts, a great convenience would be bestowed on the commercial public. We cordially agree with our contemporary in its opinion that great opportunities are being wasted by those in charge of the Metropolitan telephone business.

The American Bell Telephone Company.—In the year 1886, 9,318 new subscribers joined this company, as against 2,969 in 1885. The company's wires have a mileage of 14,185; of these, 2,613 miles are underground. The average connections for the year are 312,605,710. Among the improvements promised for the ensuing year are further extension of underground wires, and terminal facilities between New York and Boston and Philadelphia. The Philadelphia line will soon be open to the public, and the Boston line will be completed during the present year. The Canadian company's earnings have increased from $158,000 in 1885 to $190,565 in 1886. The gross earnings for 1886 were $3,097,000, against $2,765,884 in 1885; net earnings for same periods, $1,947,283 and $1,793,196. The dividends paid in 1886 came to $1,176,252 regular, and $392,084 extra dividends. The above remarkable array of figures, says the *Scientific American*, is a good illustration of what a patent may be worth. This immense business is built upon a single claim of the single 1876 patent of Alexander G. Bell. All others in the present aspect of things, such as his later patents, and the many other patents owned by the company, are of quite secondary importance. Eventually, their value will appear. A striking item is the patent account of over

nine millions of dollars, an amount very nearly equal to the capital stock. The company has acquired such financial strength that whatever the decision of the Supreme Court may be, it can view the limitation or even extinction of the Bell patent with equanimity.

The Colonial Conference and Telegraphic Communication.—The Conference met at the Colonial Office on Wednesday under the presidency of Sir Henry Holland, to discuss questions relating to submarine telegraphy. The Right Hon. H. C. Raikes, Postmaster-General, was present, accompanied by Mr. S. A. Blackwood, C.B., Secretary to the Post Office, Mr. C. H. B. Patey, C.B., Third Secretary, and M. E. H. Rea, Assistant Secretary; together with the Earl of Onslow, Under-Secretary of State for the Colonies, and Mr. W. A. Baillie-Hamilton, Secretary to the Conference. Mr. J. Pender, the Hon. H. Finch-Hatton, and Mr. R. C. Want and Mr. R. K. Gray were also present, as representing respectively the Eastern Telegraph Company, the Pacific Telegraph Company, and the Indiarubber, Gutta-percha, and Telegraph Works Company. Mr. Pender and Mr. Finch-Hatton were examined by the delegates as to proposed telegraphic arrangements.

A Tramway Director on Electric Traction.—Speaking in the discussion on Mr. Reckenzaun's paper at the Society of Arts last week, Mr. Richardson, a director of the North Metropolitan Tramway Company, said that company hoped to be able in a short time to show some practical results at Stratford. Within the last year they had obtained the necessary Act of Parliament, and the application was now before the Board of Trade for permission to run the engines of Mr. Elieson. When the system had been practically tested, there would come the question of cost, but he did not think on this point Swansea could be taken as a criterion for the metropolis, for coal there was much cheaper than in London. Besides that, the line ran by the side of the road, on agricultural land, where there was no chance of accident, and any locomotive could be used, whereas in the metropolis one which was almost noiseless would have to be employed. Their small district, where they only carried 45,000,000 or 50,000,000 of passengers per annum, could not compete with Blackpool or Brighton, but they were under more stringent regulations, and would not be permitted to lay down a third rail; there were quite accidents enough with two. They were endeavouring to give the plan a thoroughly fair trial, and were laying down very substantial rails, weighing 90 lbs. a yard, so as to carry well the engines of seven tons each.

Edison in Ireland.—A man who is believed to be insane, and who was found in the kitchen of the Viceregal Lodge, Dublin, without being able to give any explanation of his presence there, was brought up before a Dublin magistrate on Wednesday. The following letter was found on the accused:—"My Lord,—I am Edison, of the electric light and telephone, and inventor of the keyless watch. For these inventions I was offered £24,000 a year, and raised to the peerage under the title of the Duke of York, but refused to take my seat. I have no income and no money. I will accept a small income from the Government, or a situation of some kind. I am an Irishman—a native of Kerry. Will you appeal to the Government on my behalf? All the Royal Family knows of me. It is a pity a man that gave a light to the world should be in want. If you are a Spiritualist you will know me better. The Prince of Wales is Grand Master of England. I got him in. I shall be pleased to get you also. This Order is in existence 8,800 years before Adam and Eve. Having no money, I hope you will assist me, as I stated. I remain, your lordship's faithful servant, EDISON, of the Electric Light." The accused, in reply to the magistrate, spoke in a strong American accent, and said he was Edison, and it was very hard that he could not get a Government situation, as he was in want. He added that he understood the electric light was a failure in Dublin, but that was because its principle was not understood. He would undertake to light the whole of Dublin with one ton of coal a day. He wished to explain to the court the construction of the keyless watch, of which he claimed to be the inventor. The magistrate, however, said he would hear him another day, and remanded him for a week for further enquiries.

Electro-Harmonic Society.—Mr. W. H. Preece, F.R.S., has kindly consented to preside at the Smoking Concert of this society, which takes place this evening at St. James's Hall Restaurant.

The American Exhibition.—The gigantic undertaking at Earl's Court is to be opened on Monday, May 9th, and great progress has latterly been made in the preparations for that eventful day. It may fairly be expected that the exhibition of American arts and manufactures, with the romantic "Wild West Show" in connection with it, will eclipse the glories of South Kensington, and we may be excused for hoping that it will keep itself free from the taint of jobbery, the suspicion of which attaches so strongly to the memory of the international exhibitions of the last four years. Like everything else, the electric lighting of this exhibition will be of an extensive kind. Messrs. Laing, Wharton & Down have this work in hand, and we learn that 250 Thomson-Houston arc lights of 2,000 C.P. will illuminate the grounds after dark. In addition to these, further effects will be produced by the employment of nine search lights of 10,000 actual C.P. These search lights, as we have before stated, will be worked by the Anglo-American Brush Corporation. A very useful lesson to English engineers and inventors generally, including, of course, electricians, will probably be the result of this exhibition of the industry of "our American cousins."

Threatened Companies.—The names of the following amongst other companies will be struck off the register of joint stock companies at the expiration of three months from the 19th inst., unless cause is shown why they should remain:—The General Electric Society, the Ships' Electric Telegraph Company, the Singapore Straits Settlements and Siam General Electric Company, and the Synchronome Clock and Electro-Magnetic Motor Company.

Firing Guns by Electricity.—Experiments have been successfully initiated in New South Wales with a view to the adoption of the system of laying and firing guns from distant stations by means of the position finder and electrical communications.

The Schanschieff Battery.—At a meeting of the North of England Institute of Mining Engineers, at Newcastle, on Saturday, Mr. Schanschieff exhibited and explained some miner's safety lamps made with his primary single liquid battery. Mr. B. S. Coxon, who read a paper describing the lamp, expressed an opinion that the disadvantages of primary as compared with secondary batteries for this purpose would disappear in practice. Mr. Schanschieff, in reply to an objection, stated that he had an arrangement for the detection of marsh gas in his lamp, but he could not explain it till he had secured the patent. He hoped, however, to be able to show this at their next meeting.

Jolin's Pocket Galvanometer.—Messrs. P. Jolin & Co., of Bristol, wish us to state that previous to bringing out their improvement in galvanometers as described in our issue of the 8th inst., they had made a galvanometer from a sample supplied by Mr. Lewis, of the Western Counties and South Wales Telephone Company. The instrument, fitted in a watch case, had only one circuit of fine wire, and the difficulties of construction and repair were so great that Messrs. Jolin & Co. went into the matter with the result which we have already stated. The apparatus is now adopted by the company which Mr. Lewis represents.

Elieson's Secondary Cells.—In our issue of Feb. 25th last we gave an illustration and brief description of the secondary battery plates invented by Mr. C. P. Elieson, the energetic manager of the Electric Locomotive and Power Company. As our readers are aware no paste is employed in these plates, the perforations in the lead supports being filled with spirals of lead ribbon whose convolutions are separated by asbestos paper. We recently inspected the factory in Macintosh Lane, Homerton, previously occupied by Messrs. Phillips Bros., the well-known wire coverers, where the manufacture of Elieson's batteries is carried on in an extensive way. We were first introduced to the shop in which the lead grids are cast and drilled by a very simple process; then we were conducted to the spiralling department where the lead ribbon and asbestos paper are cut into strips by machinery, and rolled into spirals on a simple watchmaker's spring winder. Girls are solely employed in this work, and we were much pleased with the deft manner in which they manufactured the spirals and fitted them to the plates. These are afterwards packed to any required number, placed in accumulator boxes, and submitted to the forming process. When this has been accomplished they are disconnected and stored. There are always 5,000 plates in course of formation, and many batteries have been used for the Elieson locomotives, the lighting of Homerton Infirmary and other purposes, For the electric launch now in course of construction, for Messrs. Lester and Perkins and Mr. Elieson jointly, 5,000 plates will be required, and preparations are now in hand to make a twofold increase in the number of plates under formation. Naturally, the absence of pasting renders the construction of these batteries comparatively simple, but nevertheless the operations which we witnessed were most interesting. Mr. Elieson does not claim greater electrical efficiency for his cell than is possessed by other batteries in the market, but he claims greater durability; in fact, it has been constructed to do hard work for some time without failing. We wish the Electric Locomotive and Power Company success in its operations, and if a sanguine confidence in the future of electricity betokens prosperity, Mr. Elieson is the man to carry the fortunes of the company to this end.

Pollak and Binswanger's Tramway System.—We describe this week the method of underground conductors for electrical tramcar purposes, which Mr. Reckenzaun spoke of in his Society of Arts paper as being the invention of Messrs. Pollak and Binswanger. It is doubted in certain quarters whether the method can ever be successfully brought into practical operation, and we understand that Mr. Holroyd Smith has experimented in a similar direction without very hopeful results. The idea is certainly ingenious, and we cannot see any insurmountable difficulty in making it practically operative.

Portable Hand Dynamo.—A machine has been designed by Mr. G. Bowron, of 97, Crawford Street, London, to meet a want for a small hand dynamo capable of doing a variety of work. It is shunt wound, and is specially adapted for exploding fuses, and for medical purposes. It is superior to magneto exploders, as there are no permanent magnets, which often require re-magnetising. It will also give a current of considerable strength. The Siemens shuttle armature has a special commutator. One or both of the slits are of variable width, being wide in one part and narrow in the other. If the brushes are on that part of the commutator having wide slits, the machine gives strong shocks by means of extra currents from the field magnet coils. It is then adapted for medical purposes. If the brushes touch the narrow slits the machine can be used for exploding fuses, ringing bells, or any other purpose where weak currents are required. When strong currents are required, as for incandescent lamps, the position of the brushes is immaterial. A machine, weighing 5½ lbs., will give 12 watts, and may be packed in a 7 inch cubical case.

Electrical Appliances for the Public Service.—Two electrical appliances of a noteworthy character, says the *Scotsman*, have just been introduced into the public service in Glasgow—one at the Central Fire Station, and the other at the Central Police Office. The apparatus in Captain Paterson's department consists of a series of electric bells, used as calls to the members of the brigade, and which will greatly facilitate a speedy turn-out on an alarm of fire being received. On a wall in the office there is a board divided into three sections, each supplied by a different battery, and the whole of the bells, which number between 20 and 30, can be either rung singly or simultaneously; while, by simply turning down a switch, any one of those on the circuit can be exempt from call. Captain M'Call's department has been provided with a "telephone exchange" in the form of a neat cabinet, for which a private room has been constructed off the public hall at the Central Police Office. It has also three rows, and there is provision altogether for 25 wires, although only 13 of these have at present connections with district police and other offices, the remainder being in a position to be added when required.

Lecture.—On Wednesday evening, April 13th, Mr. Thomas P. Carswell, C.E., assistant engineer of the North British Railway, read a paper before the Philosophical Society of Glasgow, on "The Automatic Lighting of Trains on the Underground Railway." There was a good attendance, and diagrams and models made the paper more interesting. An inverted rail between the ordinary rails is laid on insulators attached to the sleepers, and the cables conveying the current from the dynamo are attached thereto. Three separate circuits are formed, viz., College to Queen Street, 748 yards; Queen Street station itself, 484 yards; and Queen Street to Charing Cross and Finnieston, 2,196 yards; and these are fed from a large compound-wound self-regulating Crompton dynamo, which is kept constantly running during the day, but stopped when the arc lighting of the high level station is taken up. There are two pulleys below the carriages of each train, which, on making contact with the special rail, conveys the positive current to the lamp or lamps, the return or negative making contact by springs to the wheels, and so on to the ordinary rails. The current is of low potential, and therefore harmless to men. The trains as they enter the tunnels make contact with the rail, and so get lit automatically, going out as they emerge into the open again. All the trains are not yet fitted, but two have been running for four months, being off one day per week for cleaning. These two trains had some sixty lamps, which would be lit for about an hour daily altogether. One lamp only had been broken maliciously, and another had given way after some hundred hours burning. This system has the advantage of each carriage being separate, and requiring no bother of connecting when trains are made up. The cost was stated to be one-fourth less than either of the English systems, and quite one-third less than gas. The cost of working the English and Scotch systems is about the same, whilst both are one-third less than for gas lighting. Mr. Carswell was accorded a vote of thanks for his instructive paper.

Personal.—Mr. T. A. Edison has been visited at Fort Myers, Fla., by a representative of the New York *World*, who "finds him anything but a sick man."

Mr. J. Willmot, of the technical branch of the Engineer-in-Chief's Office, General Post Office, has been promoted to the post of superintendent of the new Postal Telegraph Factory, Bovey Place, Holloway. Mr. Willmot was originally in the service of the Electric and International Telegraph Company, and has been in the Engineer-in-Chief's Office for 25 years, where he has done excellent work in every branch, more particularly in connection with the designing of telegraphic apparatus and the extensive pneumatic tube system which so largely supplements the ordinary telegraphic work in London and several provincial towns.

The Electric Launch "Victoria."—This boat, to which we have on several occasions referred as being the joint production of Mr. Elieson and Messrs. Lester and Perkins, is rapidly approaching completion. It is expected that in about another fortnight she will be ready for the reception of her machinery. By what one might almost term the irony of fate, the launch will carry her own steam engine and dynamo for charging the secondary cells with which she is to be supplied. The reasons for this apparent anomaly are, however, easy to understand. The *Victoria* measures 90 feet in length over all, with 11½ feet beam, and she is one of the finest specimens of the boat-builder's art ever designed, her lines being superb.

The School of Electrical Engineering and Submarine Telegraphy.—Amongst the recent additions to this well known school (Princes Street, Hanover Square), are 42 "E.P.S." accumulator or storage cells of the best type, lathes and other tools for use in the workshop, a gas engine, and, lastly, a boiler and steam engine, which have been built specially for purposes of instruction, and for illustrating the lectures on mechanical engineering, as well as for driving the five dynamo machines. With the apparatus connected with the steam engine, accurate mechanical as well as electrical tests can be taken. No expense has been spared to render the engine, dynamo, and accumulator rooms as complete as possible. In order still further to increase the efficiency of the instruction in the school, arrangements have been made with a firm of manufacturing electrical engineers (former pupils in the school) for the attendance of advanced pupils in their workshops during a certain portion of their course of instruction. Some acquaintance with practical work is thereby ensured, in addition to that obtained in the ordinary course on the school premises.

Technical Discussions.—General Brine, who took part in the discussion on Mr. Reckenzaun's paper, ought certainly to have been an Admiral, for his dogmatic assertions are made in a manner worthy of an "old salt." It would be well, however, if he would make himself acquainted with the technology of the subject under treatment before venturing upon an opinion amongst a body of scientific men. His comments illustrate very forcibly the old adage that a little knowledge is a dangerous thing.

Why?—It is a little difficult to understand the exact amount of credit which Mr. Holroyd Smith desires for original work in electric locomotion. We have time and again seen him claiming to have long known and used methods now principally associated with the systems of others, but whether or not he seriously claims to have anticipated everybody else in these matters, we are totally unable to say. For instance, at the Society of Arts last week Mr. Smith complimented Mr. Reckenzaun "on not having brought forward his claim as being the first to use worm gearing on large tramcars." This reads like a compliment to modesty—certainly well deserved—and an acknowledgment of precedency; but the phraseology which follows is so curious that we leave it to our readers to solve for themselves what, we confess, is to us a puzzle. Mr. Smith proceeded:—". . . although he (Mr. Smith) had used it on a small experimental car before, but he did not venture to adopt it for large cars until he saw Mr. Reckenzaun was successful." Now, does Mr. Smith mean that Mr. Reckenzaun is to be commended for not claiming the credit which is his due for having worked out a matter which was before in doubt, or does he wish to suggest that to himself belongs the credit because he had done the same thing before? If he really believed worm gearing to be the most useful method, why did he not adopt it in real work and thus prove by demonstration that he was first in the field with that particular device?

Electricity the Coming Motive Power for Street Railways.—In the *Street Railway Journal*, Mr. W. P. Craig, after a close examination of the various electric railway systems, and judging from 20 years' experience in the business, says:—"I have come to the conclusion that electricity is the coming motive power for street railways, but like every innovation and improvement of such magnitude and importance, it will take time to perfect it so that it will be reliable and satisfactory under all circumstances."

Lighthouse Illumination.—Professor Tyndall, as is well known, is far from satisfied with the manner in which the experiments with lighthouse illuminants at the South Foreland were conducted, and he last week wrote once more to the *Times* upon the subject. The matter was on Friday raised in the House of Commons, Mr. T. W. Russell asking whether, in consequence of the statements and complaints of Professor Tyndall and others, the Board of Trade would give the matter further and careful consideration. Baron H. De Worms replied that the statements alluded to were merely a repetition of what had been urged before and upon which a decision had been taken and placed before Parliament. In the present state of the Mercantile Marine Funds, which was not satisfactory, and having regard to the fact that experiments had been carried out so recently at a cost of £9,000, he hesitated to impose upon the general body of shipowners an additional burden by suggesting the renewal of experiments.

The Los Angeles Electric Railway.—Los Angeles, California, the first city in America to discard gas entirely for its street lighting, and to adopt the electric light in its stead, has now had in operation for two months an electric railway on the Daft system. The Los Angeles Electric Railway Company has working three miles of electric railway on Pico Street, and is building two miles more to reach the Plaza. Four cars are now in operation, the power being transmitted by means of heavy copper wires suspended overhead. Two methods are employed, one having a single overhead conductor, with rail return, and the other a double conductor throughout. According to the Los Angeles *Illustrated Herald*, the road has not failed a single day since the start, and has carried in a single afternoon on three cars, a distance of three miles, 1,500 passengers. The speed of the road is usually from 10 to 12 miles per hour, as fast as is deemed safe for the streets of the city.

Abbreviated Telegraphic Addresses.—The Postmaster-General, having been urged by the Association of Chambers of Commerce to reduce the fee of £1 1s. now charged for the registration of an abbreviated telegraphic address to 5s. after the first year, has replied that, according to the best estimate that can be formed, the actual cost incurred by the department for each registered address considerably exceeds 5s., and that such balance as may remain out of the charge of £1 1s. is far from sufficient to meet the loss of revenue involved in the reduction of the number of words in telegrams which arises from the use of an abbreviated address. Apart from its effects upon the revenue, one result of the reduction of the fee would be the increase to a large extent of the number of applications for registered addresses, and the department is not prepared to take any steps which would lead to such an extension of the system. Under the circumstances, Mr. Raikes regrets that he does not see his way to a compliance with the request.

A Farmstead Struck by Lightning.—The farmstead of Mr. Thomas Atley at Thornborough, near Thirsk, was on Saturday afternoon struck by lightning and partly unroofed. The electric current entered the house, smashed the windows, and injured two daughters and a son.

A Telephonic Concert.—At a workmen's exhibition held last week at Sunderland a very successful enter

tainment was given on Thursday. The telephone room was placed in communication with Newcastle and Middlesbrough, and from each place songs were sung and reproduced at the exhibition by means of the loud-speaking telephone. The entertainment, which was listened to by a large number of visitors, was most successful, the songs being distinctly heard all over the room. The hunting song "John Peel," sung at Newcastle, was most successfully transmitted, as was also that of "The Death of Nelson" at Middlesbrough. A number of other songs also came through very distinctly, and listeners could easily imagine that the singers were at the back of a thin partition, the words at times being reproduced with wonderful fidelity.

Electric Headlights.—There are five electric headlights in use on the Cleveland, Akron and Columbus Railway, which the president of the road declares make an annual saving to the company of not less than $50,000, probably a good deal more, by preventing accidents. The lights can be seen at night seven miles if no intervening objects obstruct the vision. Numerous incidents are related in connection with these lights. An engineer saw at night, by the aid of the light and reflector, a horse on a bridge a mile away. The president states that he has read a newspaper at night, unbelievable as it seems, by aid of a light nearly or quite three miles away. An engineer, he says, who could not see a tie or other obstruction on the track half or three-quarters of a mile away by an electric headlight had no business on the locomotive. An electric headlight and apparatus costs about $400. The little dynamo is driven by an independent little engine on the boiler of the locomotive, behind the sand dome.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrified Rooms Company, Limited.—An extraordinary general meeting of this company took place on the 26th ult. at 24, Landport Terrace, Southsea, when resolutions were passed to the effect that the company should be wound up voluntarily, and that Mr. J. R. Martyr be the liquidator. This is done with a view to reconstruction with an increased capital of £25,000 in £1 shares, each member of the present company to be entitled to 250 fully-paid shares in the reconstructed company in respect of each share held in this company. The resolutions were confirmed on the 19th inst. and duly filed on the 23rd inst.

Edison-Gower-Bell Telephone Company of Europe, Limited.—The annual return of this company made up to the 13th inst. was filed on the 19th inst. The nominal capital is £500,000 in £1 shares. The number of shares taken up is 385,009, upon which the full amount has been called. Upon 350,000 ordinary shares and 20,000 preference shares the sum of £370,000 is considered as paid. The calls paid amount to £15,005 and unpaid to £4. Registered office: 53, New Broad Street.

Automatic Electric Railway Signal Company, Limited.—The statutory return of this company made up to the 14th inst. was filed on the 22nd inst. The nominal capital is £100,000 in £1 shares, 50,007 shares have been taken up, 50,000 being considered as fully paid. Upon the remaining seven shares no call has been made. Registered office: Dashwood House, New Broad Street.

Northern District Telephone Company, Limited.—An agreement, dated 19th inst. (filed 23rd inst.), states that this company has invited the United Telephone Company, Limited, to subscribe for 2,500 preference shares of the company of £10 each, on the terms that six fully paid up ordinary shares would be allotted to the United Company or its nominees, in respect of each of the said preference shares. The United Company has applied for the whole number, and 2,500 preference shares credited with £4 per share paid up and 15,000 fully paid ordinary shares in this company has accordingly been allotted.

Provincial (Brush) Electric Light and Power Company, Limited.—The registered office of this company, formerly at 38, Basinghall Street, is removed to 13, Basinghall Street.

South-Eastern (Brush) Electric Light and Power Company, Limited.—The registered office of this company, formerly at 38, Basinghall Street, is removed to 13, Basinghall Street.

DEFUNCT COMPANIES.

The following companies, having neglected to comply with the provisions of the Companies' Acts, have been struck off the register in pursuance of S. 7 (3) of the Companies' Act, 1880:—

Electric Ships' Log Company, Limited.—This company was registered 9th July, 1879, to purchase from Mr. James Lyon Horne, of Southsea, a retired paymaster, R.N., an invention for improvements in apparatus for ascertaining the rate at which vessels are passing through the water; also applicable to ascertain the rate at which streams or currents are flowing (Letters Patent 1,455, A.D. 1876). The nominal capital was £20,000 in £10 shares. The only return filed by the company is made up to the 20th November, 1879, and shows that 257 shares were taken up, and of these 250 were allotted to the vendor as fully paid, and upon each of the remaining seven shares £2 was paid up. The office of the company was situate at 34, Parliament Street, S.W.

West Riding Telephone Exchange, Limited.—This company was registered 8th September, 1879, with a capital of £15,000 in £5 shares, to establish telephone exchanges in Halifax, Bradford, Leeds and Huddersfield. No return has been made by the company, and the only shares recorded as taken up are the seven subscribed for by the original signatories. The registered office was at Royal Insurance Buildings, Crossley Street, Halifax.

General Telephone Agency Company, Limited.—This company was originally constituted as the General Telephone Company, Limited, on the 8th September, 1879, with a capital of £2,100 in 400 shares of £5 each, and 100 founders' shares of £1 each, to manufacture telephone and telegraphic instruments and apparatus. On the 14th February, 1880, a return was filed made up to the 19th January of that year. This document shows that 228 shares were taken up and that £5 per share had been called up, the calls paid amounting to £1,120 and unpaid to £20. On the 14th of February, 1880, the name of the company was changed to the General Telephone Agency Company, Limited. On the 21st July, 1880, it was resolved at an extraordinary general meeting of the members that the company should be wound up voluntarily, and Messrs. Adam Scott, Jonathan Aldous Mays and Charlton Jones were appointed liquidators. The registered office of the company was at 223, Gresham House, Old Broad Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Eastern Extension, Australasia, and China Telegraph Company, Limited.

THE twenty-seventh ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Wednesday, Mr. John Pender presiding. The report submitted to the meeting stated that the gross receipts, inclusive of Government subsidies, amounted during the half-year to December 31st, 1886, to £216,956 2s. 8d., against £247,017 6s. 4d. for the corresponding

half-year of 1885, showing a decrease of £30,061 3s. 8d., or about the same falling off as in the first half-year. Nearly the whole of this decrease occurred in the first three months, since which time the receipts have shown a marked improvement. The reduced tariffs were, moreover, in operation during the whole six months, from which alone a loss of £25,000 was anticipated. The working and other expenses, including £30,639 15s. 6d. for cost of repairs to cables and expenses of ships, absorb £80,066 10s. 11d., against £71,473 6s. 9d. for the corresponding period of 1885, leaving a balance of £136,889 11s. 9d. From this is deducted £4,224 9s. 4d. for income tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £91,070 2s. 5d. as the net profit for the half-year, which, with £34,980 5s. 8d. brought forward from the previous half-year, leaves an available balance of £126,050 8s. 1d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, together with a bonus of 2s. per share, payable on April 28th, making with the interim dividends paid for the first half-year a total distribution of 6 per cent. for the year 1886. The balance of £38,550 8s. 1d. has been carried to the general reserve fund, which, after being debited with the cost of the Singapore-Penang (renewal) cable, amounting to £53,245 3s. 8d., now stands at £569,440 16s. 10d. In pursuance of the conditions upon which the issue was made, 108 of the company's 5 per cent. debentures of 1880 were drawn by lot on the 30th ult. for payment at par May 1st next. The company's maintenance ships have been employed on various cable repairs during the half year, but no interruptions of importance occurred to the company's system beyond the breakdown simultaneously of the Madras-Penang and Rangoon-Penang cables referred to in the last report. The difference with the Government of New Zealand respecting the renewal of the New Zealand cable subsidy, which was fully referred to at the last general meeting, resulted in the raising, on November 1st last, of the tariff for inter-colonial telegrams. Subsequently a proposal made by the Agent-General of New Zealand was accepted for reverting to the former tariff for a period of six months, in order to give an opportunity to the Parliament, on its re-assembling, to come to a decision on the subject. It is expected that the whole question of telegraphic communication will shortly be considered at the Colonial Conference now assembled in London. The land line belonging to the South Australian Government between Port Darwin and Adelaide has been well maintained during the half year under review.

Mr. F. E. Hesse, the secretary, having read the notice convening the meeting,

The Chairman after drawing attention to the figures given in the report, said he had placed before them what he believed to be in the circumstances a fairly satisfactory statement of the position of the company. It was curious that from the time they made arrangements at Berlin to advance the tariff, somehow or other, trade fell off, and consequently the outlook was not very bright. But they had learnt from past experience that there was a tendency towards steady increase in telegraphic communication, and the hopes he held out that he would be able at this meeting to put before them a better prospect than they had at the last meeting had been justified. They were not now paying 7 per cent., that was to say 5 per cent. dividend and a bonus of 2 per cent., but they were paying 5 per cent. dividend and a bonus of 1 per cent., and if things continued for the next six months as they had been for the last three months, he would be able, when he met them next, to announce once more the old dividend of 7 per per cent. When he last addressed them he referred to a discussion then going on between the New Zealand Government and the company. That discussion was rather a warm one, but the result of it was that they secured as supporters the Australian Colonies and the Australian Press, and they also secured the approval of a very large number of the New Zealand people. They practically gained the battle; there was no question that they gained the battle; but there was no use, having gained a battle, and when they were competing with a government, in persevering in unnecessary contentions. They felt that the action of the Government was going to inconvenience very seriously not only the telegraphing community of New Zealand, but also all the colonies, and they decided, upon the advice of Sir Dillon Bell, the Agent-General for New Zealand, to return to the *status quo ante* so as to remove all difficulties for the moment; that was to continue for six months, when the whole question was to be brought before the New Zealand Parliament. That Parliament was meeting about this time, and he hoped the broad, liberal, and generous course the company adopted would be appreciated by the Parliament of New Zealand, and that it would go into the matter with the desire of doing them the justice which they thought they were entitled to. He hoped that when he met the shareholders again, it would be settled in such a satisfactory way that all friction would be removed, a moderate rate established, and the support which the Government had extended to them for ten years renewed—in short, that friendly relations would be resumed. They were aware that a Colonial Conference was being held in London at the present time. The representatives of the colonies were all men who might be said to be of the cream of colonial society, and they were sent here with the view of drawing closer the relations between the mother country and the colonies. He had always held that there was nothing that had contributed more, materially and politically, to the progress of the colonies than the establishment of telegraphic communication with the mother country. He believed they all appreciated that; but they appreciated it to an extent a little beyond what the directors of this company thought was just and right. They had found such advantages arising from the use of the cables this company had laid down, that some of them wished to have additional cables laid. He thought, however, that they had shown these gentlemen that no company could give them the same advantages that this company could; this company could give lower rates than it was possible for any competing company to establish. The directors believed that they had, not a monopoly, but such a widespread system that it was impossible for private enterprise to compete with them, because, in the first place, they could do the thing cheaper than anyone else, and, secondly, there was no necessity for further cables, for they could do a great many times more work than was required of them. A statement had lately appeared in a newspaper that the rate to Australia could be reduced to 1s. per word; but they would see how impossible that was, when he told them that the "put-outs" alone, the payments to other companies to carry the messages over a certain portion of the route, would amount under the scheme proposed to 2s. per word. He was not without hope that the directors would be able to make such arrangements with the colonial authorities as would make opposition impossible. If opposition should come, it must come in such a form that the whole of the Eastern Extension system must be absorbed. There was no opposition they need fear except in the shape of Government subsidies, and no Government was likely to subsidise a competing company without taking over this system. Their position was a strong one. He believed they would have full justice from the Imperial Government and that the Colonial Governments would also recognise that they had been the pioneers of a great system which had led to an enormous development of trade in the Colonies; earnest men were at work with the view of bringing about a solution of the question which would be mutually beneficial, and he thought they might naturally look for a favourable result. He then moved the adoption of the report and the declaration of a dividend of 2s. 6d. per share, and a bonus of 2s. per share, both free of income-tax, making with previous distributions a total payment of 6 per cent. for the year 1886.

The Right Hon. Viscount Monck seconded, and the motion was carried. Mr. John Pender and Mr. George Garden Nicol, the retiring directors, and the auditors, Mr. Henry Dever and Messrs. Quilter, Ball & Co., were re-elected.

The Chairman, replying to a vote of thanks, said there was no doubt the interests of the company were in good hands. He had spent that day a couple of hours at the Colonial Conference, but, unfortunately, he was forbidden to open his mouth. The Government was now recognising, however, the great position the telegraph held, and was disposed on important occasions not only to consult the companies, but to give them an opportunity of expressing their views on questions affecting them. He thought, therefore, they would be in a position, even at the conference, to see that no harm was done, and also that a great deal of good came out of the conference. The subject of proxies having been mentioned, the Chairman took the opportunity of explaining his views regarding them. The expenses of sending out proxies was borne by the directors, but apart from that he held that it was a necessary precaution to issue them, in the interests of the large number of shareholders who were unable to attend the meetings, in order that they might be able to guard against any sudden resolution proposed by enemies of the company.

The directors notify that the coupon on the 5 per cent. debentures (1880 issue) due on May 1st prox., will be payable on and after Monday next, the 2nd prox., on presentation of the same at the Consolidated Bank, 52, Threadneedle Street, E.C. Coupons should be left three clear days for examination.

Indo-European Telegraph Company, Limited.

THE twentieth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Monday, under the presidency of Colonel James Holland, chairman of the company.

Mr. W. Andrews, managing director, having read the notice convening the meeting,

The Chairman moved the adoption of the report and accounts. (The report is published in the REVIEW for April 15th.) The current charges, he said, were, with one exception, practically similar to those of last year and required no special notice. The one exception was a favourable one; that was to say, the maintenance charges were upwards of £800 less this year than they were last, and considering that the line had been kept in perfect order during that time, he thought that was a very satisfactory item. At the same time he would caution them not to suppose that, because for the last three or four years there had been year after year a reduction in the maintenance charges, that was going on for ever. They took the greatest pains to keep the charges down, but it was absolutely necessary to their credit, character, and position that they should keep the line in the very best possible order. To do that required at all times considerable care and considerable expense, and it was quite possible that hereafter there might be a little more expense, or there might be a little less. All that they could say was that they would not spend more than was necessary to keep the line in the perfect state it was in at present. The receipts were £11,567 less than the receipts of the previous year, and reference to the report for 1885 would show the cause for that reduction. They stated then: "The large augmentation of revenue is quite exceptional, and is owing to the total interruption of the Eastern Company's lines for some three weeks, the disturbances in Burmah and the Afghan frontier question, and it is satisfactory that the £18,046 11s. 4d. of additional

revenue has only occasioned an increased expenditure on commercial account of £1,637 7s. 7d." So that they derived that year practically more than £16,000 of revenue that they had no right to expect, and which was the consequence of an accident to the Eastern Company's cables; therefore although the decrease of £11,500 looked a large sum, the reduction was less than they had any reason to expect. Notwithstanding that reduction it was a very pleasurable duty to the directors to declare a dividend of 10 per cent., and to place £10,000 to reserve. He did not think any shareholders would be disposed, considering the long-continued exceptional state of Continental politics, to think that it was anything but prudent on their part to lay down and keep up a very handsome reserve. He had spoken about the quasi-perfect state of the line. They could carry he would not say how many times more messages than they did. The line had such a wonderful capacity that were five times as many messages to come to them as actually did they could carry them with ease. Unfortunately they did not get the business. The average speed for the past year for that portion of the line which was worked by and belonged to them, that was to say rather more than half, had been 21 minutes per message. The messages took nearly two hours on an average to arrive from India, and were the Indian Government officials, or were the management of the Indian Government lines equal to theirs, instead of being two hours or one hour and three-quarters, the average time per message would only be 40 or 41 minutes. They had no right to blame the Indian Government, because, after all, although by comparison its lines did not work well, any improvement would involve expense, and the Indian Government was at all times, and now particularly, unwilling to incur any further expense than was absolutely necessary. But he mentioned it as a fact, and one that should be known, that the company did its portion of the work in little more than twenty minutes, and that its line had a practically unlimited capacity for carrying messages. They had obtained from the Russian Government, after sundry communications, the privilege of carrying certain South Russian messages, which they had no right to claim, for practically their only business was to carry messages between Europe and India; but the Russian Government, seeing the great value of their lines, had given them these messages to convey, and although it did not pay a very handsome sum, still whatever they got was a benefit. The Russian Government might, of course, at any time withdraw that privilege, but so long as they showed their ability to carry the Indian messages with the greatest possible ease and celerity it was not likely that it would be withdrawn. From the middle of last year they had reduced their rates. Everybody said, "If you want increased business reduce your rates, and bring in a lot of people who would not do any telegraphing else." Well, they reduced. A reduction of 7d. per word was a serious matter, and they had some right to expect that they would get an increase in the number of words. But it so happened—in consequence of the dulness of trade and other things—that not only were they getting fewer messages during the last few months of the year, but the number of words was very much reduced also. All they could hope for was that trade might improve. They were an adjunct and an aid to trade, and if traders had no active business many messages would not be sent. Therefore they had nothing further to do than to look with patience to the coming improvement of trade which many people spoke of, but which at present they had not felt. The only portion of the dominions worked by their line in conjunction with the Eastern Telegraph Company where an improvement was visible was Australia. There business was brisker and better. The chairman concluded by moving the resolution.

Mr. H. Weaver seconded, and the motion was carried unanimously.

The Chairman next moved the declaration of a dividend for the half-year ended December 31st, 1886, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and the payment of a bonus of 20s. per share, both free of income-tax, making, in all, 10 per cent. for the year.

Major-General G. B. Tremenheere, R.E., seconded the motion, which was agreed to.

The retiring directors, Major-General Tremenheere and Mr. J. Herbert Tritton, were re-elected, as also were the auditors, Messrs. Kemp, Ford & Co., a vote of thanks to the chairman then terminating the proceedings.

Reuter's Telegram Company, Limited.

THE twenty-third ordinary general meeting of the shareholders of this company was held at 24, Old Jewry, E.C., on Wednesday, Colonel James Holland, chairman of the company, presiding.

The Secretary having read the notice convening the meeting,

The Chairman, in moving the adoption of the report (which was published in the REVIEW last week), said he was happy to be able to congratulate the shareholders that the predictions which he ventured to make at the last annual meeting, which was rather a sorrowful one, had been borne out, and they had been able to declare a dividend of 7½ per cent. for the year and to place a substantial sum to the reserve fund. With regard to the accounts, he might observe that the sundry accounts and the sundry debtors balanced each other, and that they had substantially run off. There were a few agents' balances, which were always floating balances, but they had nothing in their accounts to indicate anything like bad or even doubtful debts. He believed the company never was in a sounder state than it was at the present time, and it was an extreme satisfaction to the board to be able to reinforce the reserve fund, and to pay back a considerable portion of it which, after last year's unfavourable time, they had had to borrow. It must be borne in mind, with regard to the reserve fund, that it was stated expressly in the articles of association that it was instituted for the purpose, amongst other things, of equalising dividends. He merely mentioned that as giving the reason why after the last annual meeting they were unhappily obliged to borrow from it. In looking down the accounts, they would see at a glance what had been the cause of the greatly improved position since that time last year. The telegrams and agencies, the great source of cost, last year amounted to £72,159, this year to £64,864; that was to say, their expenses were very nearly £8,000 less than they were last year. It was true, as a set-off against that, there was a small diminution in the receipts from the telegrams. But that was easily accounted for in this way: the great cause of expenditure was war; war was always damaging to the company, and there were last year wars and rumours of war, war in the Soudan, war in Burmah, and elsewhere, and when anything of great interest to the world was happening, or likely to happen, they were always obliged to have well-paid officials on the spot to telegraph information to them for the benefit, he might say, of the whole world. Last year was a very troublous year, and the cost to the company was very great. This year, although not altogether devoid of rumours of war and trouble, the cost had been very much less. That fact, and the judicious action of the Indian Government and the telegraph companies beyond India in lowering the Press rates, had been very beneficial, and had enabled them to pay a dividend. The chairman concluded by moving the adoption of the report.

Baron de Reuter seconded the motion, which was agreed to.

Colonel Holland was re-elected a director, and the auditors, Messrs. Quilter, Ball and Co., were re-appointed.

Mr. Keenlyside enquired if the directors had come to any decision as to the limit they would place upon the reserve fund. He thought the fund a most desirable thing, and was only too happy to see it growing. He believed the £550 which was originally paid as rent had, since the freehold of the premises in which they were then met had become the property of the company, been from year to year placed to reserve.

The Chairman replied that that was the case, but they had not fixed any sum at which additions to the reserve fund should cease. They had valued their goodwill at £65,000; this they believed to be an available asset, but until it was tested in the open market—that was to say, until they desired to sell the business, which was not, so far as he could see, very likely—no human being could say how much it would fetch. They thought it better and safer, therefore, whenever they were in a position to give a fairly liberal dividend, to make some provision for the reserve in order that the goodwill account might eventually be to a certain extent discounted.

Mr. Keenlyside asked whether, if they had sufficiently prosperous years, they could write down goodwill.

The Chairman said they hoped to write it down by degrees in moderate amounts; but they had not made up their minds decidedly upon any course of action. At present they thought the addition of £1,000, now and then, was a very desirable thing towards writing down goodwill, but as time went on and circumstances developed themselves, they would probably be in a better position to say something more definite on the subject.

A vote of thanks to the board brought the meeting to a close.

Oriental Telephone Company, Limited.

THE seventh ordinary general meeting of the shareholders of this company, held at the Cannon Street Hotel on Wednesday, was presided over by Mr. William Addison, the chairman. The directors' report for the year ended December 31st, 1886, which was submitted to the meeting, was published in the REVIEW of April 8th.

Mr. Alexr. B. Chalmers, the secretary, having read the notice convening the meeting,

The Chairman said for the first time they showed a profit on the working instead of a loss: whereas for the year 1885 the accounts showed a deficit of £1,600, for the past year they showed a profit of £2,400, or an improvement of £4,000. During the year they had expended on capital account—that was to say for extension of exchanges and for private lines—the sum of £1,600, the principal part of which had been expended at Rangoon, where they hoped to reap the benefit in the current year. The changes referred to in the last report with reference to the Mauritius had shown a beneficial result. Although the depression in trade greatly affected their business there they had made a profit of £200 on the year instead of a loss as in previous years. The liabilities to the Indian companies had proved a great drawback. He might remind them that the guarantee to the Bombay Company expired in September next and that to the Bengal Company in June following, when they would be relieved from a heavy burden. The change of system at both these places, which he told them last year was in progress, had now been completed, and the magneto system had been substituted for the Law. They had found very great benefit result from this, more particularly in Bombay, where the increase of subscriptions had been very satisfactory in consequence. In Bengal, he was sorry to say, the increase had not been so great as they had expected—Bengal did not seem to be so progressive a place as Bombay. Another hindrance to their paying a dividend was that the Egyptian

Company, although earning a large income, had no working capital, the shares never having been allotted to the public. However, they thought their position had greatly improved, and that the time was approaching when the question of paying a dividend might be taken into consideration. But before that could be they must be in the position of having the money in hand instead of being able to show it only on paper. Explaining the position of the Oriental Company in reference to the Egyptian Company, he said the shares of the latter were not allotted to the public at the time the company was formed; they were all held by this company, with a very small exception, consequently this company had had to find the working capital for the construction and maintenance of the Egyptian systems. When the present directors came into office the Egyptian Company was paying 3 per cent.; since then it had gradually improved, and for the past year it had paid a dividend of 6 per cent. Having no capital it was obliged to employ its revenue for construction and extension, and to borrow the money from this company. He thought now the Egyptian Company had arrived at so satisfactory a position that it ought to be able to place some of its shares, and if any of the Oriental shareholders wished to take some of those shares he was sure they would find them a very good investment for themselves, besides which they would be providing capital for the Egyptian Company, which would set free that company's revenue and enable it to pay its dividends in cash immediately they were declared. Previous, however, to any payment of dividend by the Oriental Company, the directors would place before the shareholders a plan for the re-arrangement of the capital whereby the liabilities of the shares, which were now 9s. per share, would be reduced. Although for a trading company it was necessary to have some margin, for the credit of the company, yet such a sum as 9s. per share was quite unnecessary. Such a reduction as he suggested would, he thought, meet the views of all the shareholders. He concluded by moving the adoption of the report.

Mr. B. St. John Ackers seconded the motion, which was unanimously carried.

The only other business was the re-election of the chairman and Mr. Frost as directors, a vote of thanks to the board closing the proceedings.

The Telephone Company of Ireland, Limited.

Mr. EDWARD DWYER-GRAY, M.P., presided over the eighth ordinary general meeting of this company at the offices, Commercial Buildings, Dublin, on Friday, the 15th inst. In moving the adoption of the report (which appeared in the REVIEW for April 8th), the Chairman said there had been steady progress during the year, and they had no reason to fear that that steady progress would not continue. The number of subscribers at the year's end had risen to 915, an increase of nearly forty for the 12 months; this was satisfactory, considering the depression in trade and the peculiar difficulties which telephone companies had had to face. The profits were sufficient to admit of the payment of an increased dividend upon the ordinary shares, or at the rate of 1¼ per cent. for the second half of the year, as against ¾ per cent. for the corresponding half of 1885; but the directors considered it more prudent to commence to build up a reserve fund and strengthen it by the addition of a substantial sum, and keep the dividend at ¾ per cent. An exchange was opened last April at Dundalk; this was worked upon the fee call system, and the experiment had proved so satisfactory that they had determined to repeat it in other towns. In order to thus extend their system, and to provide capital to meet the expenditure necessitated by the growth of the company's business, it was proposed to issue additional shares instead of calling up the unpaid balance due on the 29,776 preference shares. Incidentally, the chairman remarked that the shares which had changed hands had done so at ridiculously low prices.

Alderman Winstanley seconded the motion for the adoption of the report, which was agreed to.

The Chairman then proposed the declaration of a dividend at the rate of ¾ per cent. per annum upon the ordinary shares for the year to December 31st, 1886, and the confirmation of the interim dividend paid in August last.

Mr. H. G. Erichsen seconded, and the motion was carried.

Resolutions relating to the issue of new shares as referred to by the chairman were then passed. They were, "That the directors be and they are hereby authorised to issue 25,000 preference shares of £1 each, being the unissued portion of the total of 75,000 preference shares authorised by the Articles of Association," and "That, subject to the consent of the United Telephone Company, under seal, the directors have power to issue the whole or any portion of the said 25,000 unissued preference shares of £1 each referred to in the preceding resolution, upon such terms and subject to such conditions as they may think fit."

The retiring directors, Mr. E. D. Gray, M.P., and Mr. A. Dudgeon, and Mr. John M. Kean, the auditor, were re-elected, the usual vote of thanks to the chairman following and terminating the proceedings.

The Equitable Telephone Association, Limited.

THE first ordinary general meeting of the shareholders of this company was held at 40, Queen Victoria Street, E.C., on Friday, the 15th inst., Mr. G. C. Warden presiding.

The Chairman intimated that counsel's opinion had been taken with regard to the freedom of the company's instruments from the "Bell" and "Edison" patents with entirely favourable results, and that though every facility had been given to the United Telephone Company to contest the freedom of the said instruments, they had taken no action in the matter. The company was now preparing to place the instruments in the market and anticipated a very considerable demand.

A report was adopted, stating that more shares had been applied for than could be allotted, and that the calls had been duly paid on those issued.

The re-election of the retiring directors brought the proceedings to a close.

The West Coast of America Telegraph Company, Limited.

THE balance sheet and revenue account for the year ending December 31st, 1886, shows a gross revenue of £43,026 13s. 1d. against £45,957 10s. 10d. earned in the year 1885. The deduction of debenture interest and all other charges make the net balance of profit £11,037 3s., and adding £739 13s. 5d. brought forward from the previous year, the total sum to the credit of revenue account amounts to £11,776 16s. 5d. Out of this the following dividends have been paid:—

In September, 1886	... ...	2s. per share,	£3,000
In January, 1887	... ...	" "	3,000
			£6,000

and the directors recommend adding £5,000 to the reserve fund, making the latter £20,000, and leaving £776 16s. 5d. to be carried forward.

The falling off in the earnings of the company is due to loss in exchange and depression of trade on the West Coast of South America during the greater part of the year; however, a reaction seems to have commenced in the month of October last, and this, combined with an improvement in exchange, has since more than made up for the ground lost during the period under review.

The working expenses of the company show a small decrease upon the previous year.

The cables and repairing steamer are kept in perfect working order.

West India and Panama Telegraph Company, Limited.—The directors have decided to recommend to the shareholders at the approaching meeting that a dividend of 6s. per share be declared on account of arrears of dividend on the first preference shares.

Eastern Telegraph Company, Limited.—This company announces the payment by interest warrant on May 2nd next of interest for the half year ending April 30th, 1887, on its 4 per cent. mortgage debenture stock.

Great Northern Telegraph Company.—Messrs. C. I. Hambro and Son will pay the excess dividend on the shares of this company for the year 1886 at the rate of 5s. per share.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th April are £2,410, as compared with £3,232 in the corresponding period of 1886. The decrease is said to be owing to the interruption of the main cable, which was repaired on the 21st inst.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 22nd were £3,287.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending April 22nd amounted to £4,034.

PROCEEDINGS OF SOCIETIES.

Physical Society.

At the meeting held on the 23rd inst., Prof. W. G. ADAMS, Vice-President, in the chair, the following papers were read:—

"On Delicate Calorimetrical Thermometers and on Expansion of Thermometer Bulbs under Pressure," by Prof. PICKERING.

"Note on Magnetisation; on Sequences of Reversals," by R. H. M. BOSANQUET, M.A. Some experiments have recently been made on an iron bar whose magnetic properties under reversals with ascending values of current were first determined some years ago. The magnetic resistances have again been determined, first with ascending values of current, and afterwards with descending values. In all cases the induction was measured by reversing the current. The results generally show a greater magnetic resistance for descending values of current, except for small inductions, where the resistance was less when the experiments were performed in the above order. The paper concludes with a molecular hypotheses to explain the above results.

"On a Thermo-Dynamical Relation," by Prof. RAMSAY and Dr. S. YOUNG.

NEW PATENTS—1886.

14983A. "Mechanical devices which are periodically started by electricity." E. W. SERRELL. Dated November 18, 1886. (*Complete.*)

1887.

5365. "Acoustic or tone telegraphy." W. T. BARNARD. Dated April 13.

5405. "Mechanical or other telephones." J. M. PORTER, J. BLAKEY. Dated April 14.

5462. "Dynamo-electric machines." W. H. SCOTT, E. A. PARIS. Dated April 14.

5466. "Incandescence electric lamps." W. CLARKE. Dated April 14.

5468. "Arc lamps." T. CRABB. Dated April 15.

5505. "Dynamo-electric machines." H. W. RAVENSHAW and others. Dated April 15.

5509. "Electric arc lamps." A. J. BOULT. (Communicated by P. J. V. Létang.) Dated April 15. (*Complete.*)

5533. "Vibrating electric motors." A. L. PARCELLE. Dated April 15. (*Complete.*)

5534. "Electrical synchronous movements." A. L. PARCELLE. Dated April 15. (*Complete.*)

5537. "Telephones." H. J. MACLURE, R. D. BOWMAN. Dated April 15.

5562. "Generating, reproducing, and distributing electricity." W. MAXWELL. Dated April 16.

5583. "Galvanic batteries." H. LIEPMANN. Dated April 16.

5637. "Electrical controlling apparatus." A. SIEMENS, E. F. H. H. LAUCKERT. Dated April 18.

5638. "Thermopiles heated directly by the combustion of fuel or by heated gases." G. E. DORMAN. Dated April 18.

5642. "Electrical switch for preventing arcing when the circuit is broken." W. J. ORMSTON. Dated April 18.

5643. "Electrical switch for coupling up cells or groups of cells." W. J. ORMSTON. Dated April 18.

5648. "Making and breaking electric circuits." J. H. HOLMES. Dated April 18.

5687. "Fusible connections for armatures for electric generators." W. P. THOMPSON. (Communicated by H. W. Sprang.) Dated April 19. (*Complete.*)

5692. "System of sewerage for buildings and mechanical and electro-magnetic devices for apparatus used in connection therewith." C. H. SHEPHERD. Dated April 19. (*Complete.*)

5704. "Bending electrical cut-outs, fuses, &c." G. C. SILLAR. Dated April 19. (*Complete.*)

5707. "Automatic cut-outs for electric arc lamps worked in series." E. F. H. H. LAUCKERT, H. W. KINGSTON. Dated April 19.

5709. "Dynamo-electric machines." A. J. GRAVIER. Dated April 19.

5717. "Electric signalling chiefly for use in connection with submarine cables." H. H. LAKE. (Communicated by M. G. Farmer.) Dated April 19. (*Complete.*)

5720. "Dynamo-electric machines." C. COERPER. Dated April 19.

5735. "Administering electricity to the human body in Turkish baths." M. HUMM. Dated April 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

1193. "Improvements in incandescent electric lamps." O. E. WOODHOUSE and F. L. RAWSON. Dated January 26. 8d. Claims:—1. In an incandescent electric lamp the combination of two or more filaments therein of widely different candle-power with any known electrical switch controlled automatically by the current or by hand by which the current may be diverted from the larger to the smaller filament or filaments or *vice versâ*, at pleasure, substantially as described. 2. In an incandescent electric lamp the combination of two filaments therein of widely different candle-power with any known automatic or hand switch and a suitable resistance in circuit with the smaller filament to prevent rupture of the latter, substantially as described. 3. The combination of two or more filaments of widely different candle-power in separate globes with any known automatic or hand switch, and a resistance in the circuit of the smaller filament or filaments in series when the larger and smaller filaments are in multiple arc, and in parallel when the larger and smaller filaments are in series, substantially as described. 4. The combination of two or more incandescent electric light filaments in one or more globes, the filaments being arranged in multiple arc for a bright light with any known switch, by which the filaments may be placed in series for a subdued light, substantially as described. 5. The combination of two or more incandescent electric light filaments of widely different candle-power in one or more globes, the filaments being in series when small light is required, with any known switch by which the smaller filament or filaments may be short circuited, to allow the larger filaments to become incandescent, substantially as described.

2975. "Improvements in dynamo-electric machines." N. TESLA. Dated March 2. 8d. Claims:—First. The combination with the commutator having two or more main brushes, and an auxiliary brush, of the field helices having their ends connected to the main brushes and a branch or shunt connection from an intermediate point of the field helices to the auxiliary brush, and means for varying the relative position upon the commutator of the respective brushes, substantially as set forth. Second. The combination with the commutator and main brushes and one or more shunt connections of the field helices in the main circuits and one or more shunt connections from the field helices to the auxiliary brushes, the relative positions upon the commutator of the respective brushes being adjustable, for the purposes set forth.

3475. "Improvements in dynamo-electric machines." R. E. B. CROMPTON. Dated March 11. 6d. Claims:—1. In a dynamo-electric machine used as a motor the combination or arrangement and use of a high resistance armature, high resistance field magnets of the character described, movable brush holder and field coupling arrangements, together with the ordinary accessory parts, whereby the machine is enabled to bear the whole E.M.F. of circuit even when at rest, and is capable of regulation as to torque, speed and direction of rotation, in manner and for the purposes set forth. 2. In a dynamo-electric machine used as a motor the combination or arrangement and use of parts for facilitating the regulation of the machine by effecting the coupling of the field magnet coils of the machine and the movements of the brushes by one and the same movement given to a handle or equivalent operating part, as set forth.

3508. "Improvements in electric light fittings." R. E. B. CROMPTON and W. A. KYLE. Dated March 12. 8d. Claim:—In an electric light fitting the combination or arrangement and use of parts for suspending a lamp, so that by a pull on the pendant the current may be switched on and off, as set forth.

3577. "Improvements in the method of depolarising electric batteries." A. C. HENDERSON. (Communicated from abroad by E. Bazin, of Paris.) Dated March 13. 11d. Relates to improvements on a former patent, No. 10,536, 1884. In this patent both the positive and negative electrodes in the form of discs are made to rotate on a common axis worked by hand or by a dynamo-electric motor. The improvements on this invention consist in having the zinc or positive electrodes stationary and causing the negative or carbon discs only to revolve in the exciting liquid, which in this case is or may be bichromate of potash or soda. The claims are 7 in number.

4522. "A process for utilising the spent liquid from certain voltaic batteries." W. S. SQUIRE. Dated March 31. 4d. Claim:—The described process for treating the spent liquid from a voltaic battery in which caustic alkali is used as exciting liquid and zinc as one of the elements, the said process consisting of the following steps, namely, subjecting the liquid to the action of sulphuretted hydrogen either directly or indirectly as described, thereby recovering solution of caustic alkali and precipitating zinc sulphide; treating as described the zinc sulphide thus precipitated with acid to produce a zinc salt and to reproduce sulphuretted hydrogen for use in the manner above referred to; and treating as described the zinc salt thus produced with barium sulphide for the production of pigments.

7737. "Improvements in electric arc lamps." H. MOEHRING. Dated June 9. 8d. In this invention the carbons being forced together or apart, by a comparatively great power in a uniform and steady manner. The claims are four in number.

11413. "Improvements in electric safety lamps for use in mines." M. SETTLE. Dated September 8. 8d. Claims:—1. In an electric safety lamp for use in mines, the combination of an air and liquid tight glass vessel containing water or other suitable fluid with a float or other equivalent device placed within the same and supporting the incandescent electric lamp: the float or its equivalent, and the cover of the glass vessel, being provided with contact pieces in electric connection with the electric lamp, and with main conducting wires respectively: and so arranged that the escape of the water or other fluid will cause the float or its equivalent to fall so as to break electric contact and extinguish the light. 2. The combination with an electric safety lamp of the construction described of a spring bolt for the purpose of preventing the accidental restoration of electric contact between the wires after the same has once been broken, all being constructed and arranged substantially as and for the purposes described and illustrated by the drawings.

12315. "Improvements in automatic electric cut-outs." A. BERNSTEIN. Dated Sept. 28. 8d. Relates to the cut-out referred to in the number of the REVIEW for Jan. 14th, 1887. Claims:—1. An automatic electric cut-out consisting of two electrodes between which is placed a metallic compound which offers a comparatively high resistance to the passage of the current of normal strength but is decomposed by a current of abnormal strength and then becomes of low resistance. 2. In an electric circuit, in which electric devices are placed in series, the use of a cut-out containing a metallic compound, which is reduced to a metallic state by reason of an abnormal current passing through it. 3. The manufacture and use of the improved automatic electric cut-outs described.

CORRESPONDENCE.

Technical Training.

In your leader of April 15th you expressed a desire to ascertain the ideas entertained by readers of your esteemed Journal "on the subject of technical education, with special reference to the teaching at Finsbury and South Kensington." I was in hopes of finding in this week's issue some response to your invitation, but there is none, with the exception of the note of Prof. Silvanus Thompson, who merely asks intending correspondents "not to confuse together five things, each of which is distinct and independent," mentioning only the systems of instruction and examinations instituted by the City and Guilds of London. If the City and Guilds of London Institute could be taken as the standard of excellence in technical training, then it would be an easy matter to start a criticism on the basis of the systems pursued by that body, but there are numerous schools or colleges in this country which make technical instruction the primary object of their usefulness, therefore it would be unfair to select any one institution as representing a universal or national standard of technical training. There is, in fact, no such thing as a national standard of technical education in Great Britain; this may be fortunate, or unfortunate to the community at large, according to the final effects produced upon the greatest number. The value of the final effects depends upon the *general usefulness* of those who received the education, and not upon certificates, titles or prizes conferred by any particular institute. Such distinctions are certainly an incentive to exertion, they are a means to an end, but by many students, unfortunately, they are regarded as *the* end of their education, and this is particularly the case with students of continental technical high schools. In several countries on the continent, notably in Austria and Germany, there exists a national standard of technical training; to have passed through a "high school" confers the title of *engineer* (ingenieur), in the same way as the title of "Doctor" may be obtained by students of universities. To *have* the title "ingenieur" is the ambition of many; to *be* an engineer is the fortune of few. Of the thousands who attend these high schools, hundreds obtain positions in the civil service, in the army, on railways, or in engineering works; perhaps 20 per cent. of the bulk of students become real *engineers;* the large majority, however, disappear among the multitude, and follow various callings where the "super-technical" training which has cost the State a lot of money is of no use whatever to them, and after a few years many of these individuals have nothing left of their training but the "diploma." Two-thirds of these possessors of "diplomas" are by *nature* unfit to become engineers in the real sense of the word; they have "knowledge" but no "understanding:" heads with brains and memories, but no aptitude to apply their store of knowledge.

This is not a desirable state of things to be imitated. Continental Governments have long ago found out that technical training alone does not produce an engineer, and another institution has sprung up within the last 20 years called the "Gewerbeschule" or Trades School, where apprentices and journeymen obtain technical instruction on subjects relating to their particular trades. These trades' schools are of immense benefit to the various industries. Here the handicraftsman obtains a good deal of technical training, and he can, if particularly clever, afterwards attend the lectures of the Polytechnic High School. Continental manufacturers encourage, and in many cases even compel, their apprentices to attend the trades' schools. In this country it is rather the exception than the rule for manufacturers to trouble about the technical education of their workmen, although they value and promote the most intelligent, as I have often had occasion to observe.

Some 12 years ago, when in the employment of Messrs. Easton and Anderson, I was encouraged by that eminent firm to establish evening classes in connection with the South Kensington Science and Art Department. For several years I taught *employés* of the Iron Works "Machine construction and drawing," "Steam," and "Solid geometry." The firm did not compel any one to attend my classes, but nearly all who went through the whole course obtained certificates, and several are now holding responsible positions in various parts of the world. That they have risen above their original status of journeymen was no doubt due to their own inclination, but this good tendency was fostered directly by the Science and Art Department, and I maintain that this institution has done an incalculable amount of good. The City and Guilds of London Institute is conferring similar benefits in a still more practical form, and Prof. Ayrton has shown that *technical training* is now being developed to a considerable extent and in the right direction, but I believe that the rapid advance demanded by the times and foreign competition can only be effected through a hearty co-operation, the support and encouragement of all employers of skilled labour.

A. Reckenzaun.

April 23rd, 1887.

Single Needle Duplexing.

I write to state that after two months' trial, this continues to be a *complete success*, very advantageous to railway working, and can be seen in operation on the Glasgow-Carlisle circuit, by any one interested. Indeed, so satisfied am I with the result of the above, that I am about to put the same in operation between Glasgow and Aberdeen, a distance of over 150 miles, with three intermediate stations thereon.

I may also add that I have received several letters of inquiry regarding it, which *proves* that it is both *new* and interesting to many of your readers.

And. S. Dunn.

Note on the Performance of some Dynamos.

I enclose a table correcting a few errors in the very interesting table by Mr. D. C. Jackson in this week's ELECTRICAL REVIEW.

Machine.	Revs. per minute.	Velocities.	I.	II.	III.	E.M.F.	Current.
Edison-Hopkinson	800	2100	·483	·0138	·00060	110	300
Goolden-Trotter ...	800	3000	·378	·0075	·00047	130	200
" " ...	765	2140	·264	·0074	·00034	56	285
" " ...	950	2850	·289	·0061	·00030	60	200

It will be seen that for the Goolden-Trotter Dynamo, 56 v., 285 d., the figures in columns I., II. and III. should be about doubled. The error has evidently occurred from the fact that the armature is wound with two wires in parallel, and the compiler has taken the effective length to be 440 feet instead of 220 feet. The figures in column II., Goolden-Trotter, 60 v., 200 d., should be ·0061, and I have filled in the remaining columns.

Column II. of the Edison-Hopkinson should be ·483, and column III., ·0006 not ·006. I have checked from Mr. Kapp's figures in the paper read before the Inst. Civil Engineers, November, 1885.

The errors pointed out are rather serious, as they make out the Goolden-Trotter Dynamos to be little better than "old Grammes," which would be very damaging to the reputation of both makers and designer.

H. Ravenshaw.